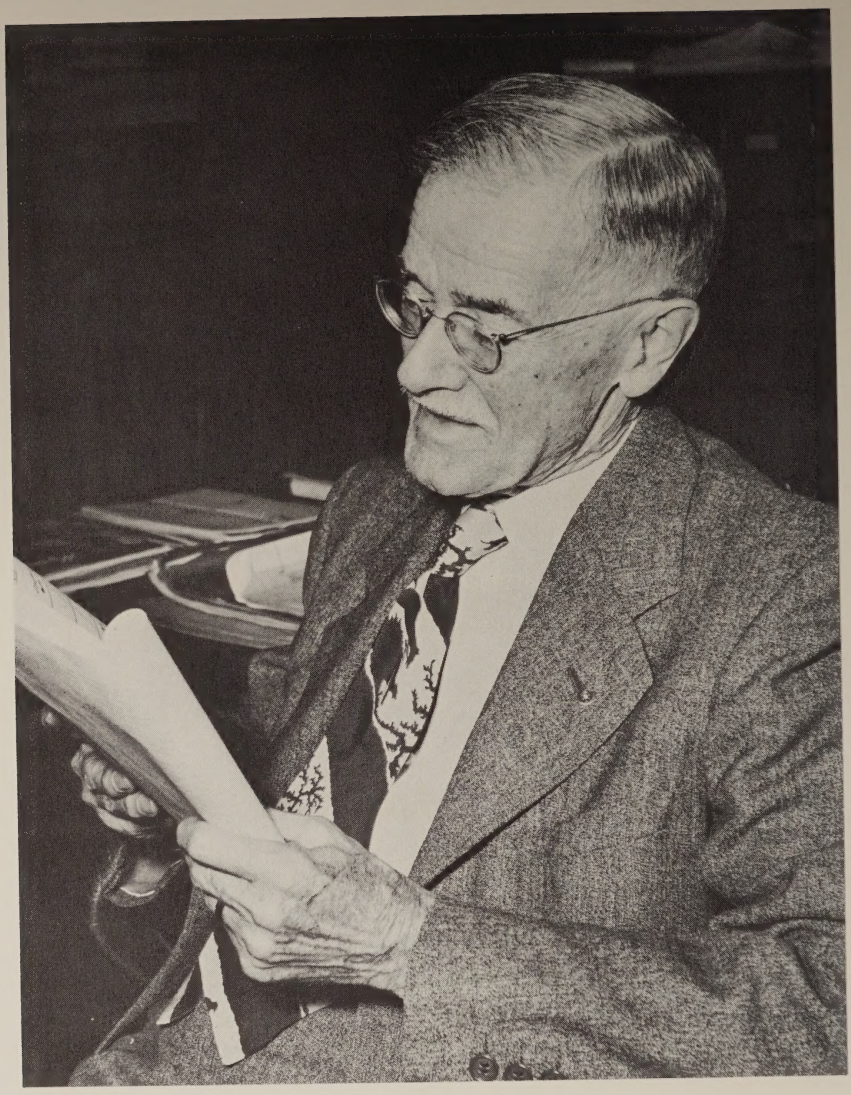
A HISTORY OF Civil Engineering AT Iowa State College

ALMON H. FULLER



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FOREWORD

Dr. Fuller assembled this history and finished his writing in 1954. Since then several events of importance to the Civil Engineering Department have occurred. The author was made Professor Emeritus at the June 1957 Commencement; Professor Schlick died after a lengthy illness on February 5, 1957, and Professor Stewart died unexpectedly in Chicago on August 25, 1957. Dr. M. S. Coover, former Head of Electrical Engineering, acting Dean of Engineering, was given the additional assignment as acting Head of Civil Engineering until a worthy successor to Dean Marston, Professor Fuller, and Professor Stewart is found.

Some additional information has been added, bringing the record up to 1956 in figures 1 and 2. The editor takes responsibility for any errors in those additions. The author's work was carefully and accurately done.

Thanks are due to the Civil Engineering alumni who critiqued the advance mimeographed copies sent them. Their suggestions and corrections have all been acted upon by the editor.

Special thanks are due to the several alumni who underwrote the publishing of this history and to Mr. John E. Granson, Director of the Alumni Achievement Fund, who made the financial arrangements.

J. H. Bolton

PREFACE

Much of the genuine satisfaction in writing this sketch of Civil Engineering at Iowa State College has come through the inspiration from Anson Marston who asked me, early in 1920, if I would be interested in coming to Iowa State. Many of the facts which have been used and the interpretation of those facts have come from Lowell O. Stewart whom I asked in 1924 if he would be interested in joining our C. E. staff. I have ever been pleased that each of us eventually received and accepted a call.

Dean Marston, Professor Stewart and I have shared the privilege of recruiting and guiding the civil engineering staff since the days of a one man faculty.

Dean Marston assumed the leadership at the time when American colleges began to grow. He contributed much to the development of engineering and engineering education, not only to the College but to the Nation. He was one of the strong men of his time.

During the Twenties and the depression Thirties, when I had the honor of serving as head of the department, the ability, devotion, and spirit of the staff were responsible for the continued effective performance.

After 1938 Professor Stewart's wise guidance was instrumental in the recovery from the depression years, the ups and downs of two wars and the substantial growth which followed. In my judgment Professor Stewart was ever broadening in outlook and effectiveness. He contributed much. The department, the College, and the City of Ames suffered a definite loss at his sudden death.

A. H. Fuller

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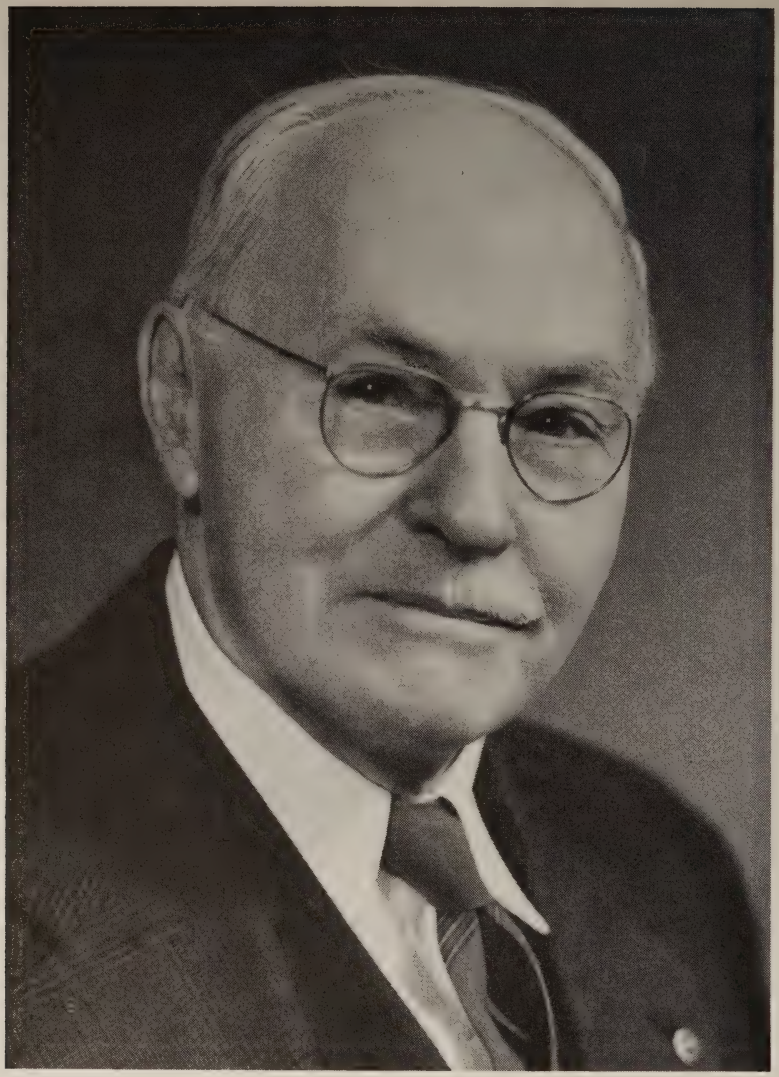

ANSON MARSTON,
First head of Civil Engineering and first dean of Engineering

INTRODUCTION

Iowa State College, then known as Iowa Agricultural College, was opened for collegiate work in March, 1869, with one curriculum in engineering and one in agriculture. The engineering curriculum was divided, about two years later, into civil and mechanical engineering. The first graduating class, in 1872, included four civil engineers out of a total number of twenty-six.

The first sentence in Chapter 1 of "A History of Iowa State College" by Earle D. Ross, 1942, is: "The Iowa State College, in its conception, was not 'just another college' to promote local aspirations, to satisfy sectarian zeal, or to provide personal gratification." This is followed a half page later by: "For this 'Industrial Movement' was an effort to keep education in line with the trend of a democratizing and industrializing nation, by providing a technological training that was popularly available. The ultimate solution was the modern land-grant college of which that of Iowa was to be typical."

The record of the development of the department of Civil Engineering is written with the thought that the reader will refer to Professor Ross' broader treatise for the main historic background of the College as a whole.

The College opened its doors at a time when agriculture was by far the greatest industry in the state. The records show that a large proportion of the early students and faculty came to I.S.C. because of agricultural and science interests. Engineering work in the College and the state has grown with the industrial development in the country and in the state. Income from industrial concerns reached that from agriculture several years ago and is still gaining. Likewise, the college enrollment in engineering has passed that of agriculture.

Civil engineering was the largest of the engineering departments for a couple of decades. The other departments grew with the manufacturing industries. The civils have grown at the less spectacular pace of general construction.

For the first thirty years the college year was from February to late November with a long winter vacation. The catalog for 1898–99 announced a change with the college year from late August to mid June but retained for some years a winter vacation of more than a month.

The College operated on the semester plan till World War I. The change to three quarters of regular work plus a summer quarter is still used, although a number of efforts have been made to transfer back to the semester plan.

BUILDINGS

At the opening of the College in 1869 all collegiate work was in a brick building, Old Main.* The first part of the "new" Engineering Hall was built in 1883. By 1884 all of the engineering work was transferred to this building with civil engineering on the top floor. This brick building, near the hospital, is still in use. The occupancy has changed and the changes are reflected in various official names as follows:

Engineering Hall	1883–1903
Engineering Laboratory	1903–1909
Structural and Hydraulic Laboratory	1909–1918
Civil Engineering Laboratory	1918–1934
Laboratory of Mechanics	1934–1948
T & AM Laboratory, since	1948

With the exception of the materials and hydraulic laboratories, civil engineering was housed in the new engineering building which was completed in 1903 until the move to more commodious quarters in the Engineering Annex during the Autumn of 1951.

The various official names of the 1903 building have been:

Main Engineering Hall	1900–1903
Engineering Hall	1903–1947
Marston Hall, since	1947

* Old Main was also used as a dormitory for men and women students and the faculty. "Old Main" was called Main Building or Main College Building while it was in use. In later years, after it burned it received the more nostalgic appellation.

CURRICULUM

The first curriculum in civil engineering was identical with the one in agriculture for three semesters and with the one in mechanical engineering for three years. The first catalog was issued in 1880. The early reports of the Board of Trustees included material which later was published in the catalogs. The first curriculum for civil engineering (as given in the third biennial report, January, 1870) was:

First year; algebra, geometry, physical geography, physiology and hygiene, rhetoric, English language and literature, bookkeeping.

Second year; trigonometry, mensuration and surveying, general chemistry, botany and vegetable physics, chemical physics, analytical geometry, descriptive geometry.

Third year; mechanics of engineering, shades, shadows and perspective, machine drawing, differential and integral calculus.

Fourth year; history and principles of architecture, architectural drawing, carpentry and masonry, political economy and logic, mental philosophy, constitutional law, civil engineering.

French and German languages, music, and freehand drawing were optional throughout the course.

The above curriculum (as copied from the 1870 biennial report) differs in detail from that which has found its way into other reports. The differences are too small to affect the general scope and spirit of the beginnings which have formed the groundwork for later studies. That this curriculum was well designed to meet the problems of the time seems apparent. Successful early graduates suggest that the subjects were well taught. Succeeding catalogs show a gradual transition based upon a principle which still exists, that of dropping one subject to make room for another which becomes imperative because of new information and changing conditions.

Basic work on curricula, methods of teaching, entrance requirements and other significant work of a college is done as committee projects. Such studies are usually followed by written reports. A list of a few of these reports by committees of the C.E. Department, the Engineering Division, and the College Faculty (with C.E. representatives) is on file in the C.E. office. They indicate the nature of studies which have contributed to the development of the curricula and the efficiency of teaching and administration. Individual discussion has been resisted, except for a few notes and comments, because many representative ones have been reflected in the TWENTY YEAR DEVELOPMENT PROGRAM which was issued in 1933 and revised in 1935.

A discussion of the Civil Engineering Chapter of the *Twenty Year Plan* is presented in Appendix A. Professor L. O. Stewart, as Head of the Department since 1938, has carried most of the responsibility for working under the plan.

Changes have naturally been made in the first curriculum in accordance with developments here and elsewhere in engineering and in education.

The spirit of the early curricula is given in a three page presentation of civil engineering by Professor F. E. L. Beal in a report of the Board of Trustees for the years 1876–77, a 347 page publication.

A few quotations from Professor Beal's report indicate a scope of curriculum that is much different from the present one. They also suggest that the instruction was in charge of a man who was then grappling with problems which still get attention in education discussions.

"...to furnish students a practical and thorough course in the application of mathematics and physical sciences to the profession."

Then follows an interesting discussion in which *reasons* are promised for the "practical" work and even "theoretic solution of the ideal problem which is never found in nature."

"We know of no system of education, and the last century has failed to show any, that give broader and more enlightened culture than the thorough working out of some particular line of research."

A NATIONAL SOCIETY FOR ENGINEERING EDUCATION

The founding of the Society for the Promotion of Engineering Education in 1893 followed a need for a nation-wide study of engineering education. This society has held annual meetings (at Ames in 1915 and 1956) and published annual PROCEEDINGS. The growth of the society in members, in organization, and in activities has been great. The name was changed to the American Society for Engineering Education in 1946. The I.S.C. faculty has always been well represented by membership, by attendance at and participation in the meetings, by committee assignments, as members of the general council, and of the Civil Engineering Division. Anson Marston was president in 1914–15.

The S.P.E.E. and A.S.E.E. have been instrumental in providing a number of formal national studies of engineering education. A list of these studies is given in "Sources of Information."

In these national studies of engineering education is evidence of a continuing development of the relation between the college offerings and the needs of engineering practice. Data are not available for a really satisfying comparison. As a basis for attempting an appraisal, excerpts were made from the national reports, and certain tabulations were made from I.S.C. catalogs.

In table 1 are the condensed results of a number of curricular studies from I.S.C. catalogs. The subjects are arranged under the headings which were used by the A.S.E.E. Evaluation Committee in the interim report, 1954, and published in ENGINEERING EDUCATION for June, 1954. Columns 4 and 5 were combined in the final report, which was published in ENGINEERING EDUCATION for September, 1955, and issued in pamphlet form.

Table I gives indications of various trends:

1. Humanistic-Social studies show a drop until the middle Twenties, and then an increase.
2. Mathematics and basic science show a similar decrease and then a further slight decrease.
3. Departmental offerings show no general trends till the middle Nineties, then, in spite of the high total credits in the first decade of the century, a sharp increase to the middle Twenties, then a decrease.
4. Engineering science reveals nothing more, perhaps, than local changes which were due to available courses and differences of opinion. The low figures in the Eighties and Nineties may reflect the temporary turn to non-departmental engineering courses.
5. Non-departmental engineering may indicate a desire to broaden the engineering offerings without being able to find many courses which seemed to fit into the curriculum as a whole.
6. The use of options, etc.* appears to be erratic. This may reflect the sharp differences in opinion through the years.

Discussion of the Trends. Following table 1 on the same page are suggested figures, for each of the headings, from the evaluation reports of 1954 and 1955. These reflect a few sharp differences between the two reports, a year apart, including a recession from the extreme position in 1954 of departmental offerings.

Previous to the Twenties, the I.S.C. curricula, as those in other colleges, were the product of individual studies through the years. They reflect the local judgment in general. The later

* Options or Electives in (a) Humanistic and Social Studies, (b) Basic Science, (c) Engineering Science, (d) Research or Theses, (e) Engineering Analysis and Design, (f) Management. (from p. 22, Evaluation Report.)

trends suggest an attempt to inject the findings of the national reports. For instance, beginning with the Twenties, when the Mann report had been digested to some extent, table 1 begins to reflect a changing attitude along certain lines, such as:

1. A return to greater offerings in humanistic and social studies.
2. A halt in the decrease in mathematics and basic science.
3. A slight decrease, due perhaps more to consolidation than elimination, in departmental offerings.

The various reports following that of Dr. Mann in 1918 gave new emphasis to promising features of the previous ones up to and including the 1955 REPORT ON EVALUATION OF ENGINEERING EDUCATION. This work might well be recognized as representing the consensus of college faculties and the employers of college graduates to a much greater extent than any of the previous studies. That two preliminary reports were reviewed, and sharply criticized at times, by various committees, means that they reflect more than the original views of the members of the national committee.

Table 1. Summary of Time Distribution
For Civil Engineering Curricula
From I.S.C. Catalogs

Year	1 Hum-Soc.	2 Math. & Basic Sciences	3 Engr. Science	4 Non-Dept'l Engr.	5 De-part-mental	6 Options, Etc.	7 Total Qtr. Credits
'71–72	..	..	..	..	..	..	..
'73–74	..	..	..	..	..	..	..
'75–76	..	..	..	..	..	..	..
'80–81	46+	83	29	9	50+	..	217
'85–86	60	68	19	10	67+	..	224
'90–91	54	70+	37	12	50—	..	223
'95–96	39	88+	39	..	66	..	232
'00–01	38+	77—	46+	..	84	1+	247
'05–06	39	76+	48	6	80—	12	261
'10–11	28+	62	38—	9	73—	9	219
'15–16	21	63	36	3	75	15	213
'20–21	20	62	41	4	77	14	218
'25–26	33	62	43	2	68	8	216
'30–31	28	59	38	4	67	17	213
'35–36	26	59	34	6	61	24	210
'40–41	29	59	34	6	60	21	209
'45–46	39	58	32	6	63	12	210
'50–51	42	56	32	3	63	15	211
'55–56	36	59	37	3	64	12	211
Subjects, but not credit hours were recorded previous to 1880. Extension of Table 1 to include, for the same headings, Some Recommendations from the Evaluation Reports.							
1955	40	50—	50	..	50*	20	210
1954	32—	54	54	11—	32—	26—	209

* May include subjects from 1954, Column 4.

Many in the civil engineering field still have an uneasy feeling that the views of industry as reflected in the report are those of the manufacturing industries without much reference to the construction industry, which is primarily in the C.E. field. A few C.E.'s have recently begun to express themselves on the subject. Among the leaders is Benjamin A. Whisler, '30, Head of the Department of Civil Engineering at Pennsylvania State University.† Those in the construction industry, mostly in the civil engineering field, have not pushed their point of view.

The American Society of Civil Engineers has recently appointed a Task Committee on Engineering Education. The committee has already made two reports:

1. By Harry C. Banks at the San Diego meeting, February, 1955.
2. By Adolph J. Ackerman, Chairman, at St. Louis, June, 1955.

These papers were published in Vol. 25, CIVIL ENGINEERING, in August and September, respectively. In the latter one, a request was made for an attempt "To prepare a plan for financing a comprehensive survey and analysis of the civil engineering profession and its educational problems, the emphasis to be particularly on the subject of civil engineering education." The A.S.C.E. committee has been working rather than writing since 1955. A report is promised in 1957.

Various indications during the past few years suggest that the civil engineering profession, as well as engineering in general, is on the verge of an early self appraisal.

A one page summary is a part of the thirty-six page 1955 report, EVALUATION OF ENGINEERING EDUCATION. The part of the summary which deals with curriculum includes the introductory sentence: "Engineering education must contribute to the development of men who can face new and difficult engineering situations with imagination and competence." It then calls for:

1. A strengthening of the three basic sciences, mathematics, chemistry, and physics;
2. The inclusion of six engineering sciences as a common core;
3. An integrated study of engineering analysis, design, and engineering systems for professional background;
4. Elective subjects to develop the special talents of individual students;

† ENGINEERING EDUCATION, Vol. 45, October, 1954, pp. 142–46.

5. A continuing effort to strengthen and integrate work in the humanistic and social sciences into engineering programs.
6. A high level performance in the oral, written, and graphical communication of ideas.

Preceding an attempt to compare the I.S.C. curriculum in general with the suggestions of the Evaluation Committee, a brief discussion will be made of the much-talked-about and little understood question of humanistic-social studies or, to use the term in the 1955 report, humanities and social studies.

The term "humanistic-social," as distinct from "scientific-technical," apparently came into use in the 1940's. The division was made after recognition of the fact that, while the engineering graduate adjusted himself effectively in the technical phases of his work, only occasionally did one rise to the challenge of organization, management, financing, and the understanding of the other fellow's point of view.

The lack of these characteristics was recognized by Mann and by Wickenden and has drawn discussion in the subsequent reports. The reports do not attempt to specify the amount or the subjects for the humanistic-social content. They carry the impression, however, that both amount and specific subjects should depend upon local situations. Some reports suggest twenty percent of the curriculum as the lower limit. Twenty percent of our present curriculum would be above forty quarter hours.

English composition, history, economics, and non-technical subjects appear as humanistic-social content for most institutions. In some discussions, English composition is declared to be a necessary tool and should not be included as a liberal subject.

The data are too meager for the drawing of conclusions. They seem to indicate, however, that a half dozen institutions had increased the humanistic-social content to approach the suggested twenty percent by 1945. Others have doubtless made gains in the meantime. Table 1 and other local data indicate that the C.E. Department of Iowa State College has made a gradual increase since 1890 but is still far short of the ideal. A greater recognition of liberal subjects has been prevented by:

1. A reluctance to reduce the emphasis on basic science and engineering applications.
2. A hesitation to accept the general subjects which were available. The writer recalls a visit to the engineering cabinet by President Hughes early in his administration. He made a

plea for a broadening of all the engineering curricula. The reply was that we were ready to include more general subjects but did not believe it wise to throw our students into existing classes. Immediate steps did not develop, but, as a later step to meet our viewpoint, John Vieg was brought to the campus in 1937 as Assistant Professor of History and Government. No change in required hours was made till 1950 (after Professor Vieg had left) but there was an increase in interest and, doubtless, in efficiency. In an institution of this nature the problem of offering really desirable courses to meet the needs and interests of engineering students is a challenging one.

An I.S.C. engineering curriculum committee made an interesting study in 1947. The report was written by Robley Winfrey '22, chairman, then a member of the C.E. staff. The report suggests, as a goal to strive for, a humanistic-social content of around thirty percent. Although English and speech are included in the fifty-seven credits, the committee felt those subjects should not be included within the minimum of twenty percent of the curriculum or a little more than forty hours.

The suggested humanistic-social content is as follows:

	Quarter	Credit
Freshman year		
English I, II, III	9	
Sequence courses in biology, psychology and sociology	9	18
Sophomore year		
Speech	3	
Economics	6	
Accounting*	3	
Philosophy and logic	3	
English IV	3	18
Junior year		
History and government	9	
Report writing	3	12
Senior year		
Humanistic-Social electives	9	9
Total quarter credits		57

The Evaluation Committee (in its report on pages 16 and 17 in paragraph form and with explanation in detail) suggests for:

Humanistic and social studies

History
Economics
Government
} Essential to competence as a citizen.

* Perhaps accounting is not a humanistic-social study, but it is considered essential to the program.

Literature Sociology Philosophy Psychology Fine Arts	Means for broadening the engineer's intellectual outlook.
English	Both utilitarian and humanistic
Accounting Management Industrial finance Marketing Personnel administration, etc.	Do not adequately fulfil the main purpose.

A statement is made (p. 17) that selections from these should comprise about twenty percent of the curriculum. That would mean more than forty quarter credit hours.

A comparison of the humanistic-social contents of the I.S.C., C.E. curricula from 1945 to 1955 (table 1) with the suggestions of the Evaluation Committee in 1955 at first appears to be very favorable. A closer look, however, reveals the fact that much has been included which the Evaluation Committee hesitates to recognize. The final listings for humanistic-social of the Evaluation Committee is given on page 14. I.S.C.'s English is primarily composition and speech, while the Evaluation Committee, in a guarded statement (on page 17 of the 1955 printed report) considers that as essentially professional and recognizes only the literature in English courses as really humanistic.

This all suggests that while the I.S.C. faculty, and those from other colleges, are making definite gestures, very few as yet have recognized and accepted the full viewpoint of the national committee. There are indications that continued thought and experiments will bring changes. Some of these changes may be somewhat of a retreat from the liberal arts viewpoint and an acceptance of the statement that teaching is really more important than subject matter in contributing to the qualities expressed in the first paragraph of the summary. (page 2 of 1955 printed report. Quoted in part on page 7).

ENROLLMENT AND DEGREES

College enrollment figures give only the approximate number in attendance at any given time and are significant only for establishing comparative results. The available data for enrollment and for degrees have been tabulated and are presented in condensed form by plotted curves. Each ordinate or

figure is for a calendar year (three quarters and both summer sessions). Shown in figure 1 are:

1. Undergraduate enrollment for the college.
2. Undergraduate enrollment for the engineering division.
3. Undergraduate enrollment for civil engineering.

Classes were first held in a preliminary term from October, 1868, to January, 1869 (Ross, p. 62). The first regular year 1869–70, the registration (Ross, p. 69) opened with ninety-three freshmen, seventy-seven men and sixteen women, plus eighty preparatory students, fifty-nine men and twenty-one women. The total registration for the year was one hundred ninety-two from fifty-eight counties. The records do not indicate the number in each department. The records do show the number of graduates in each department. For civil engineering the number fluctuates from one to ten up to 1900 with an average slightly above four. With the figures for degrees beginning in

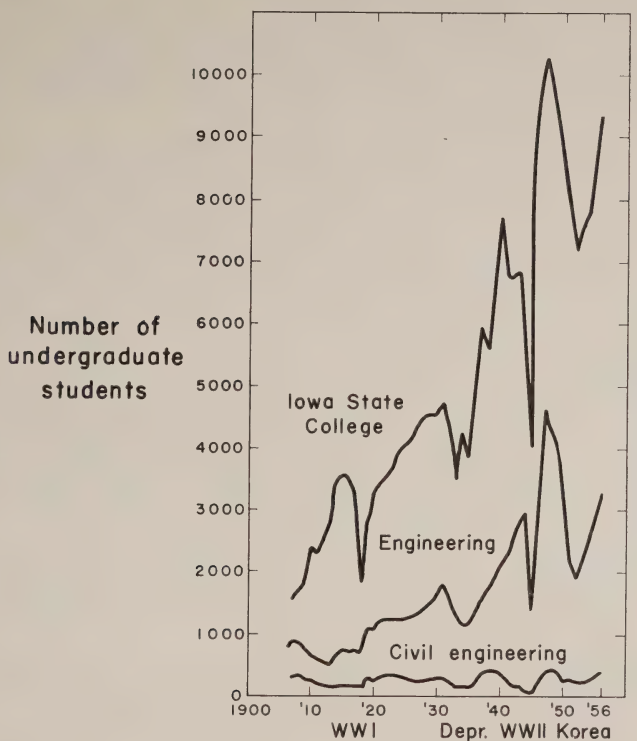

Figure 1. Iowa State College undergraduate enrollment by calendar years.

1872, and enrollment figures back to 1888, the enrollment figures for the early years may be assumed with sufficient precision to indicate a correct general trend.

Figure 1 suggests that the early enrollment of the college increased from about two hundred in 1870 to nearly three hundred in 1890, (over three hundred at times) increased at a higher rate for fifteen years to above eight hundred in 1904 and then jumped. In addition to minor fluctuations, the rapid increase was checked by the First World War (1917–20), by the depression Thirties, and by the Second World War in the middle Forties. The engineering and the civil engineering enrollment followed a similar pattern. Maximum I.S.C. figures are 3,500 in 1915, 4,800 in 1932, 7,500 in 1940 and over ten thousand during the large G.I. enrollment 1947–49. The civil engineering figures for the same years were approximately 175, 250, 300, and 400. Since 1950 the enrollment dropped to 7,189 (I.S.C.) and 213 (C.E.) and have since been gaining regularly to 8,600 (I.S.C.) and 354 (C.E.) in 1955.

The curves for "engineering" and "civil engineering" are incomplete because the names of students have been given without departments in catalogs previous to 1888. The position of these two curves, previous to 1888, may be assumed within reasonable limits.

Since the Eighties, the number of C.E. graduates remained fairly constant until 1890, except that the number rose to ten in 1884 and 1892. After 1890 it rose rapidly to above fifty in 1909. It dropped to about twenty-five within five years. It was above forty during 1924–26, remained mostly under thirty through World War II, then rose rapidly to over one hundred with the large numbers of returning veterans, then dropped to from fifty to sixty.

The master's degree in civil engineering was first conferred upon two men in 1924. The number varied from three to ten for the next ten years and then disappeared through the depression Thirties. The number averaged above fifteen from 1947 to 1951. Since then it has dropped to below ten except for the classes with military officers.

No record is found of a doctor's degree in C.E. till 1927, when there was one, and another in 1930. There were none until 1946, when there were four. Thirteen doctor's degrees were conferred during the following decade.

The number of professional C.E. degrees granted up to 1952, when such degrees were suspended, is eighty-seven. The first such degree was granted in 1903. Ten were given in 1914 and twelve in 1919.

Early Graduates. The following table of the graduates from 1872 to 1881 indicates:

1. That the early students were mostly in science and agriculture.
2. The numbers were fairly constant for the first decade.
3. The early students in engineering were largely civils.

Table 2. Number of Graduates, 1872–81

	I.S.C.	C.E.	M.E.
1872	26	4	2
1873	15	2	–
1874	19	4	–
1875	20	4	1
1876	22	5	–
1877	22	1	2
1878	21	6	–
1879	21	3	3
1880	18	--	–
1881	20	4	4
Total	204	33	12

BUDGETS

The curves on figure 2 indicate the expenditures for the division of engineering, and for civil engineering they begin with 1933. Previous to that time the carefully kept records placed

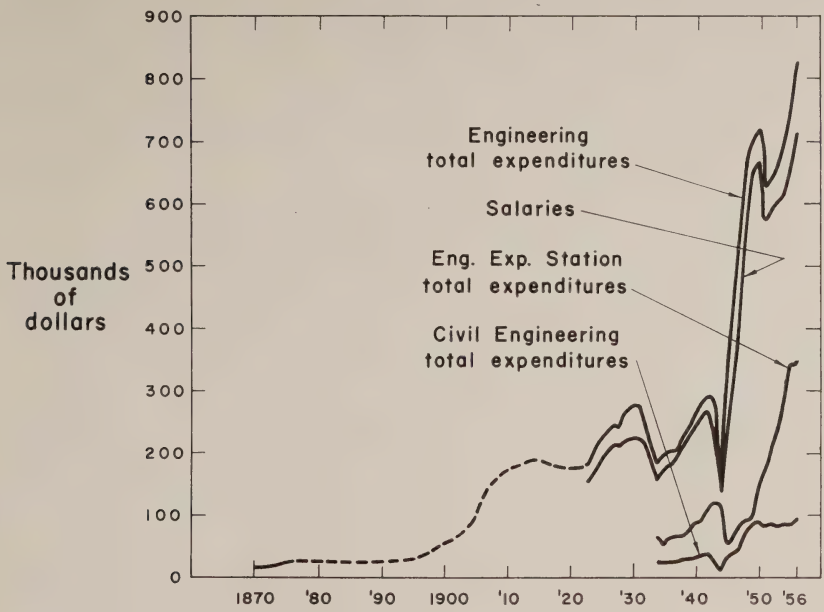

Figure 2. Division of engineering expenditures.

the expenditures in such large groups that individual items, as those on figure 2, could be obtained only by going back of the published reports. This would involve a great amount of work without the assurance that individual items could be found.

In the third biennial report, the total expenditures for the college are given as $17,456.00 in 1870 and $18,037.00 in 1871, of which $11,009.00 and $14,915.00, respectively, were for salaries. The fourth report gives the appropriation for total expenditures as $25,000.00 for 1875. These data have been added to figure 2, with a broken line for 1875 to 1923. These have been determined by assuming the ordinates for total engineering expenditures to vary in about the same proportion as the enrollment figures on figure 1. No precison is claimed for the improvised figures but they may indicate a fairly adequate general trend.

The two curves for total expenditures in engineering indicate clearly that the greater part of income is assigned to salaries. Salary curves for C.E. and Engineering Experiment Station would tend to follow those for total expenditures and would give information of value beyond that which could be assumed from total engineering expenditures.

No attempt will be made to analyze the salary situation in general. However, a little available information of the beginning salaries is added as a matter of interest. Professor Jones' salary in 1869 is reported as $2,000.00 while the Presidential salary was $3,000.00 One other professor was reported for $2,000.00. In 1871, Professor Jones' salary was $2,400.00 to include his extra duties as "cashier," while the other two salaries remained unchanged.

THE CIVIL ENGINEERING FACULTY

Among the able men in the instruction staff of the civil engineering department, Anson Marston stands unchallenged as the outstanding leader. When he took charge in 1892, he evidently found a favorable atmosphere which he maintained and improved through the years.

The first member of the C.E. staff was George W. Jones, Jr. According to the 1870 report of the Board of Trustees, he was then professor of mathematics. He was acting president for a few months in 1868 after the appointment of President Welch and before President Welch reached Ames. He also assumed the duties of "cashier" at about that time and continued with them during his time at the college. As cashier, he kept financial

records and, under individual authorization from the president, paid the bills.

The fourth biennial report of the trustees, 1872, gave Jones' position as professor of mathematics, architecture* and civil engineering, apparently beginning in 1871. That report also announced William A. Anthony as professor of physics and mechanics, and General James L. Geddes as professor of military tactics and engineering. The 1872 report indicated the subjects taught by the three men in 1871 as follows:

Professor Jones: Arithmetic, algebra, geometry, trigonometry, analytic geometry, calculus, descriptive geometry, surveying and farm engineering.

Professor Anthony: Physics, mechanics, shades, shadows, and perspective, mechanical drawing.

General Geddes: Topographical drawing, freehand drawing and bookkeeping in addition to military subjects.

The year 1871, therefore, was the beginning of engineering subjects except for the surveying by Professor Jones the previous year. The juniors of 1871 were seniors the following year and graduated with the first I.S.C. class in 1872.

Professor Jones was an able man who left Iowa State College in 1873 to join the mathematics staff at Cornell University. The writer, while a graduate student at Cornell 1897–98, frequently heard of an efficient and popular professor of mathematics by name of Jones. He even met him briefly at a reception and was impressed by his cordiality and friendliness. A later check gives assurance that he was the same Jones who first guided the civil engineering work at Iowa State. He remained at Cornell for many years and retained an interest in Iowa State College. He was instrumental in securing for the College in 1892 the services of one of his promising students, Anson Marston. The Ross history includes a more complete discussion of Professor Jones and the part he played at Ames during the early years.

After Jones' withdrawal in 1873, he was followed by A. H. Porter, (1874–76) who was a graduate of Dartmouth and the Thayer School and who had worked for the U. S. Coast and Geodetic Survey.† He was followed by F. E. L. Beal who came in 1876 and remained until 1882. He was a graduate of M.I.T. who had taught at the U.S. Naval Academy.† Charles F. Mount

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* Soon dropped. Apparently very little work was offered in architecture during the early years.

† Ross, *History of Iowa State College*, p. 129.

'78 (the first alumnus on the staff) came immediately after graduation and remained till 1891. He thus overlapped Beal for four years (1878–82). During those years, Beal was evidently breaking in Mount and gradually transferring his own interests to zoology. Professor L. H. Pammel, a stalwart for the college from 1889 to 1929 in the Botany Department and for whom Pammel Court was named, wrote a brief biographical sketch of Professor Beal which showed his definite interest in zoology. He gradually transferred his interest and was in charge of zoology in 1880–83.* The departments of mathematics and civil engineering were separated in 1876. Therefore, Beal was the first man in charge of the separate department of civil engineering.

There is also much to support the belief that Mount was an able man. The writer has discussed his tenure with several graduates of the 1880's, and invariably has gotten a favorable impression of his teaching and his stature. Little has been learned, so far, concerning Church who was here 1891–92. The faculty list which follows shows B. N. Moss '91 as on the staff 1892–93. Miss Elizabeth Tiernan's records† show him as instructor in the C.E. Department and Story County surveyor in 1892 with a C.E. degree from Cornell University in 1893. The record in the treasurer's office indicates that he was an assistant in C.E. in the year 1892–3 without specifying any further details.

The records, as far as available, point definitely to able instruction and guidance through the Seventies and Eighties. Anson Marston certainly gave excellent guidance from 1892 as long as he was active, and at the same time demonstrated the grasp of research and organization discussed elsewhere. He had a capable assistant from 1893 to 1905 in Miss Elmina Wilson '92, the first woman to graduate in civil engineering and also the first on the instruction staff. Many people to this day vouch for her ability, personality, and contribution to the department.

Marston and Miss Wilson carried on alone till 1905, when she withdrew. The department as well as the college began to grow after the turn of the Century. In 1910, there were four on the instruction staff; nine in 1920. The number remained about constant till the depression of the Thirties when it dropped to six. Since then, there has been an irregular increase to twenty-two in 1955.

During the early years here, as elsewhere, each member of the faculty was called upon to teach several subjects. As the

* *Ibid.* p. 141.

† Biographical Directory of ISC Graduates. 1952.

numbers of students and faculty began to grow, and as the profession continued to develop, various degrees of specialization naturally began to creep in. This tendency to specialize encouraged research and, when used with intelligent caution, probably increased the efficiency of teaching.

HIGHWAYS

Perhaps the first example of specialization in the C.E. Department was in 1904. Then Thomas H. MacDonald '04 was asked to undertake the dual duties of instruction in highways and in laying the foundations for the road program in the state. He withdrew from the instruction staff in 1907 to begin a notable career to which a brief sketch is given on page 43.

Thomas R. Agg '05 was brought to the staff in 1914 after a few years with the Illinois Division of Highways and in teaching at the University of Illinois. After Agg became assistant dean in 1931, the major responsibility for instruction in the highway field was taken by Ralph A. Moyer.

Moyer came in 1921, primarily as an assistant to Walter Foster in railroads, then a major subject. As the emphasis of transportation shifted from railways to highways, Moyer seemed to be the natural choice to assist Agg in his expanding work and to succeed him when he was called to the Dean's office. With Marston and Agg still available for consultation, and with ideas and initiative of his own, he maintained the prestige of the college in the highway field. His researches in tractive resistance and skidding and highway safety (Bulletin 120) gave him recognition as a leader in these lines. In 1948, he accepted an offer from the University of California.

Robley Winfrey '22, on the Engineering Experiment Station staff from 1922, joined the C. E. staff in 1939 with work in valuation, highway management, and traffic control. He contributed much through those subjects, committee work, etc. He with Frank Kerekes developed a text MANUAL OF REPORT PREPARATION. He resigned in 1952 to take charge of the training of personnel for the U. S. Bureau of Public Roads.

Ladis H. Csanyi assumed the direction of the highway work in 1949. He came with a rich experience especially in traffic problems and with asphalts and asphalt pavements. Among the younger men he has broken in are Robert M. Nady and Hon Pong Fung.

SANITARY

In 1906, Marston began to turn over the teaching in the sanitary field to Morris I. Evinger who had just graduated. He remained till 1917 when he left to work for a water purification

firm and later went to the University of Nebraska to take charge of the program in sanitary engineering there.

In 1917, C. S. Nichols '09, who had been working under Dean Marston in the Engineering Experiment Station and who prepared the 1912 DIRECTORY OF ENGINEERING GRADUATES, was put in charge of the courses in sanitary engineering. He was granted a year's leave in 1925 to go with the city of Miami. He resigned in 1926 to remain in Florida. He was City Engineer of Miami a few years. Byron Bird '12 came in 1925 to take Nichols' work for a year until he withdrew in 1926. Then Harry W. Jenks came as Associate Professor and W. E. Galligan as instructor. Professor Jenks left after three years when Mr. Galligan was advanced to Assistant Professor and was put in charge of sanitary engineering.

Professor Gordon M. Fair of Harvard was secured as consultant for a time. He was in Ames for three days in the Fall of 1929. The liaison which was formed between Professor Fair and Professor Galligan, and to an extent with the entire staff, was stimulating at the time and informally helpful for many years.

Benjamin A. Whisler '30, after a year of graduate work at I.S.C., was a graduate assistant during the year 1931–32. After three years' experience in sanitary engineering and a Ph.D. degree at Harvard in 1936, he returned as instructor, was advanced to Assistant Professor in 1940, became Associate Professor in 1945, and resigned in 1946 to become the Head of Civil Engineering at Pennsylvania State University.

Professor Galligan, with help from James P. McKean and Whisler, remained in charge until 1953 when he resigned to give full time to engineering practice. Incidentally, one of his clients in the meantime has been Iowa State College.

In the Fall of 1953, E. Robert Baumann, with a recent Ph.D. from the University of Illinois, came as Associate Professor and Paul E. Morgan '44, from several years of practice with the Engineering Division of the Iowa State Department of Health, came as Assistant Professor. Each of those men has already given promise of maintaining high standards.

RAILROADS

The location and construction of railroads had always been a definite part of a civil engineering curriculum from the beginnings of Iowa State College to the end of the first third of the Twentieth Century. By 1910, the transportation emphasis began to shift from railways to highways.

Marston, as far as available records show, was the first member of our staff with definite experience in railway engineering. Walter L. Foster '06 had thirteen years of railroad and construction experience before joining the staff in 1919. Ralph A. Moyer, after a year in railroad work, was brought to I.S.C. in 1921 to help carry the growing load in railroads, highways and surveying. As previously stated, he gradually assumed more responsibility in highways and was placed in charge in 1930.

The diminishing railroad load was handled by Foster until his death in 1934. Since that time, Moyer and others have cared for that work.

CONSTRUCTION

The construction industry is frequently referred to as greatest of the country's industries with the possible exception of farming. It has developed gradually from an art into a science and a mighty business. Finch in ENGINEERING AND WESTERN CIVILIZATION (p. 232) says, "There is unfortunately no adequate history either of construction methods or of construction equipment and machines." The wonderful structures of ancient times required intelligence, patience, and numberless workers. After the invention of printing, the records of construction practice began to be available. However, construction is one of the skills which developed slowly until the beginning of the Twentieth Century and then jumped. By the end of the first quarter of the Century, the need began to be recognized for college training in construction.

Iowa State College first offered such a course in the late Twenties. Walter Foster, with construction experience (as previously noted), was put in charge. He organized the course and, until his death in 1934, was the instructor.

The course was based upon principles rather than the details of practice. It won the respect of students and staff.

Upon the sudden death of Professor Foster in 1934, Assistant Professor Raymond G. Paustian '29 was asked to take the course. He had had but little of construction experience but had won his spurs as a potential teacher. In the depression years another staff member was not justified, and Professor Paustian was put in charge. The belief that he would early get construction experience, master the underlying principles, and produce a really good course was fully justified. Wilfred T. Hosmer '30 was added to the staff in 1946, and the construction course was assigned to him after Paustian's death in 1947. Preliminary experience, followed by several years as county engineer in Cherokee County, had given him an excellent background.

Each of these three men has made a definite contribution to the recognition of construction as an integral part of a C.E. curriculum.

STRUCTURAL

While many of the early graduates found their main life work in the structural field, the first member of the faculty with a preponderance of structural interests and experience was J. E. Kirkham, 1907–19. He developed and published a textbook, STRUCTURAL ENGINEERING (1914). He was followed by Robert A. Caughey (1919 to date), who produced a textbook, REINFORCED CONCRETE (1936). In 1920, Almon H. Fuller, a structural man, became Head of the Department of Civil Engineering when Dean Marston relinquished the post to concentrate on the duties of Dean. Frank Kerekes, who came the same year with responsibilities in drawing, was later transferred to structures. The two men produced a text in 1933 which was revised and enlarged in 1936. It was ANALYSIS AND DESIGN OF STEEL STRUCTURES, Fuller and Kerekes. (Mr. Kerekes was later joint author with Robley Winfrey for the text, MANUAL OF REPORT PREPARATION. It was first issued in 1948 and revised and enlarged in 1951.)

The large increase in the staff following World War II included three men whose work was mainly in the structural field. They were: William C. Alsmyer, Cornie L. Hulsbos '41, and James P. Michalos. Each of the three men has subsequently taken the Ph.D. degree and written theses in the structural field. Dr. Michalos has also published several papers and bulletins. He resigned in 1954 to become Chairman of the C.E. Department at New York University. Joseph H. Senne was added in 1954 as Assistant Professor. Dr. Alsmeyer resigned in 1956.

Each of these staff members has had definite experience in outside structural work and has been active in engineering societies. The older men have held numerous official positions and committee appointments in engineering societies, including the A.S.C.E. and A.S.E.E., during the years and have contributed many papers, discussions, and committee reports and bulletins. The younger men are beginning to pick up the load.

SOILS

The capacity of soils to support and transmit loads has received widespread attention for perhaps a couple of decades. Before that period, individual efforts had laid the groundwork. An outstanding individual effort was inaugurated by Anson

Marston and was brought to the attention of the world in Engineering Experiment Station Bulletin No. 31 in 1913. The theoretical and experimental work of those days is still yielding significant results under the direction of M. G. Spangler.

The subject was approached in another manner by Agg, Moyer, and associates as a supporting medium for pavement and even for "dirt roads."

The first staff member with primary interests in soil mechanics, to use the term of the day, was Harland Winn during the year 1939–40. After he left, the responsibility for directing the soils work as a distinct subject was turned over to Spangler.

In 1946 Donald T. Davidson, a graduate assistant 1940–42, returned to the College as instructor in civil engineering with part time in the Engineering Experiment Station. He worked with Spangler in soils, which soon became of major interest to him. The work was eventually divided with Spangler retaining the "culverts" phase of the work, that is, the load on the culvert or underground conduit, and Davidson developing the fundamental factors in soil engineering. W. J. Schlick, who became a member of the civil engineering staff in 1949 after many years with the Engineering Experiment Station, also made definite contributions to various phases of the soils work.

A well equipped laboratory has been provided. There is evidence of worthwhile research, excellent instruction, and effective cooperation between the personnel of the soils work and those who must use the general results in the design of highways, railways, and foundations.

ENGINEERING MATERIALS

During the early years, the materials courses were handled by the one man staff.

Roy Crum '07, on the staff from 1907–19, appears to be the first to devote time and enthusiasm primarily to instruction and research in the materials field. He was assisted by C. A. Baughman and made an outstanding contribution to the use of Iowa sands and gravels in the rapidly growing use of concrete.

Mr. Crum was succeeded in 1919 by John H. Griffith who, for many years, had done notable work with the U. S. Bureau of Standards. Professor Griffith devoted much of his time to research. Clare A. Poland assisted in instruction work. Mr. Poland died in late 1920. Clifford E. Williams succeeded Poland in 1921–22. C. M. Fisher '14 followed till 1924 when Walter M. Dunagan '23 was brought in. As the work in materials expanded, Mr. Dunagan grew with it. He was advanced to Assistant Professor in 1928 and assumed increased responsibility and recog-

nition until all work in materials was transferred to the department of Theoretical and Applied Mechanics in 1933. Professor Griffith was also transferred to T. & A.M. in 1933. Professor Griffith died in July, 1938; Professor Dunagan in November, 1941.

MECHANICS

The course work in statics, dynamics, and mechanics of materials for I.S.C. had always been given by the M.E. Department until 1931 when it was turned over to the new department of Theoretical and Applied Mechanics.

DRAWING

The teaching of drawing as a medium of communication of ideas has always been a part of the C.E. curriculum. The term "descriptive geometry" has generally been used as a background for complicated situations until recent years when "graphic theory" seems to be replacing it.

Regardless of the name, there has been a constant recognition that an engineer must be able to show by means of neat and accurate drawings the outlines of fields, buildings, etc., which he has measured and objects which he has designed. The drawing must be sufficiently clear to indicate just what the engineer wishes to convey to those who make use of it.

The department of Civil Engineering apparently taught most of the drawing courses to its own students until a separate department of drawing was established about 1933.

Before 1920, the C.E. drawing was handled by various instructors as part-time work under directions from the head of the department. In 1920 Frank Kerekes was brought in with the special responsibility for developing the work in drawing. The mimeographed notes which he developed were published in 1928 in a textbook, Engineering Drawing Theory with Applications. A couple of years later, when his main interest had become structures and he was needed in that line, the work in drawing was put in charge of Raymond G. Paustian '29. Mr. Paustian had done outstanding work in drawing as a student under Professor Kerekes and had followed it with some high grade commercial work. In 1932, he prepared a very unusual report. This report included a general discussion, outlines and objectives for each course and, for each course, a description and discussion of the work and a set of drawings (perhaps complete) of students' work.

SURVEYING

All of the early men taught surveying. The first one, perhaps, to recognize surveying as a major subject, was John S. Dodds '12, "Jack," as he was affectionately called by those who knew him well. A discussion of his work is given under *Summer Camp*. That section also refers to the effective work of Rudolph J. Lubsen '23, whom Professor Stewart, as Head of Department, put in charge after the death of Professor Dodds.

Lowell O. Stewart, who came in 1924 after several years' experience with the U. S. Coast & Geodetic Survey and the Michigan Highway Department, early demonstrated an interest and a competence in the surveying field. He also had classes in drawing, elementary structures and other subjects.

Professor Stewart's interest in surveying led him to study old records of early surveying, especially in regard to the historical and legal phases and, in 1935, to produce a two hundred page book, PUBLIC LAND SURVEYS, HISTORY, INSTRUCTIONS, METHODS. Professor Stewart was author of CAREERS IN ENGINEERING in 1941 and associate editor in 1943 of ORIGINAL INSTRUCTIONS GOVERNING PUBLIC LAND SURVEYS IN IOWA.

Dodds, Stewart, and Lubsen have recognized surveying, not simply as a tool to secure necessary information but as a basic part of civil engineering. As such they considered that it required an insight into the broader aspects which require an understanding application of statutory law as a basis of making, recording, and designating in the field the legal "corners"; of the relation of the curvature of the earth; the science of astronomy; and the possibility of obtaining much essential information by means of aerial photography. The term "photogrammetry" has recently come into common use and is becoming an important part of many enterprises.

Surveying is an integral part of most civil engineering enterprises. It is a part of every civil engineering curriculum. Many of the C.E. graduates have surveying experience; for a few surveying becomes a life's work.

Early alumni, those who graduated during the era of expansion of the railroads, usually found their first experience in railroad location and construction. After the first decade of the Twentieth Century, the emphasis in the surveying field shifted to the location and construction of water supply, sewerage and irrigation systems, roads, streets, bridges, buildings, and to the maintenance of all of these structures.

Surveying has been effective as a first application of mathematics, in developing thought, initiative, responsibility, and the knack of working with men, and as an introduction to the various phases of civil engineering. A greater emphasis has been given to surveying at I.S.C. than at many other colleges. Such emphasis may be a large factor in the success of alumni. To give this emphasis and to develop other desirable qualities, a summer camp of surveying has been maintained much of the time.

Summer Camp. The first I.S.C. catalog reference to a summer camp appears to be in the 1898–99 issue. "...go into Camp for two weeks each summer vacation beginning the Monday before Commencement and conduct an organized topographical survey of some region of the state. Each year's work will continue that of the preceding year until a large area is mapped. Lower classmen will serve in subordinate positions. Upper classmen will have responsible charge of parties and will do the triangulation and final mapping. When the survey is thoroughly organized, there will be student officers selected from the best and most experienced students."

Students usually attended in two or three successive years with the upperclassmen in charge of parties.

In the 1901–2 catalog (and succeeding ones, including 1905–6): "At present, a strip about three miles wide, half on each side of the Des Moines River is being mapped."

The next catalog announced a transfer to the Spirit-Okoboji Lakes region with L. E. Ashbaugh and F. C. French '96 as instructors. The two weeks' camp followed the school year, was continued until 1914 (or 1915) in the same general location until a tract of seventy-seven acres had been covered. Bulletin 32, A Topographical Survey of the Spirit and Okoboji Lakes Region, was produced in 1913 by H. C. Ford.

The catalog for 1915–16 announces a change in the location and the nature of the summer camp. The duration of the camp in the summer was to be two weeks. Each student was to attend two summers. The catalog also stated that summer engineering experience, under the direction of a competent engineer, could be accepted in lieu of summer camp. The location was to be in the vicinity of the College. To quote from the catalog, the camp was to "duplicate actual working conditions in such branches as highway, sanitary, mining, and structural engineering. The available lines probably be limited to one or two for each summer and varied from year to year." The first locations were along the Des Moines River, near Moingona.

Although this camp was carried in the catalog to the 1920-

21 issue, the work was "temporarily discontinued" at the outbreak of the First World War in 1917.

After the war, a careful analysis of the merits of a summer camp led to the continuation of the general policy but with a modification of many details. A six weeks' camp was provided to follow the sophomore year. The location was subject to change. Only one camp was to be required for each student.

The site first chosen was on Brown's Bay on Rainy Lake in northern Minnesota in the Minnesota State Forest Preserve, about forty miles east of Ranier, Minnesota. It could be reached only by boat. A lease was obtained from the State of Minnesota which carried authorization to erect semi-permanent buildings and to use the necessary adjoining territory. A camp was first established in 1923.

The terrain was unnecessarily rugged for the purpose. Otherwise the remote location gave opportunity for acquaintance among the group, students and staff. It helped to develop a spirit which accepted the required physical exertion while maintaining a high degree of engineering efficiency. A very high proportion of students and staff were, and still seem to be, enthusiastic about the Rainy Lake experience. Much of the success of the camp was due to Professor J. S. Dodds as director and to the teaching staff and the cooks whom he selected.

The catalog for 1929–30 was the first to announce the definite location at Brown's Bay. It added: "The camp site is one of America's few remaining spots of unspoiled natural wilderness." This site was announced in the catalogs, including the one for 1939–40.

For three reasons another review of the summer camp was made in the late Thirties:

1. The buildings at Brown's Bay needed extensive repairs.
2. An abandoned Civilian Conservation Camp (C.C.C.) near Wirt, Minnesota, was available.
3. It was within automobile range of Ames.

The Wirt site was first used in 1939, although the first catalog announcement appeared in the 1940–41 issue. For 1943–44, a summer camp was announced without location. A statement was added "suspended during the War." In 1947–48, the "suspended" statement was dropped. The location was not added. However, the Wirt site has been used continuously to the present time.

Since the death of Professor Dodds in 1950, Professor R. J. Lubsen has been in charge. All reports indicate a continuation of the high efficiency and spirit of former camps.

The camp at Wirt, without the extreme isolation at Brown's Bay, has developed a new characteristic which is becoming a tangible asset. It has cooperated with the County Engineer in the location of county roads; with the town of Wirt in surveying the town and locating various improvements; with the local Forest Ranger in certain problems; with the U. S. Land Office in tying all surveys in with the Fifth Principal Meridian.

These bits of cooperation have contributed to the general efficiency of the camp and established a friendly bond with the people of the vicinity. They refer to the students as "our boys." They come to the camp movies. They noticed one day that one of the fellows drove through a town at a too high speed. Instead of stopping the fellow at the time, someone later dropped in for a friendly call. There was no "complaint." The tactful handling of the matter developed a spirit which prevented a repetition of that example of thoughtlessness.

The Wirt camp was also used by Northwestern University from about 1940 to 1951. They came in the early part of the summer, while the I.S.C. camp was held late enough to return directly to the campus in time for the fall quarter.

Student summer camp organizations have been developed: Beta Kappa Epsilon at Brown's Bay and Tau Lambda Rho at Wirt. Each has contributed in fostering a spirit of friendliness and loyalty. Occasional meetings during the year at Ames have been instrumental in maintaining an interest. Only those who have attended camp are eligible for membership.

The Brown's Bay site was used in 1937 for a conference of teachers of surveying. Professor Dodds had taken the initiative by informally discussing the matter with representatives of other institutions and with I.S.C. men. Upon his invitation, forty-one men and twenty-eight women and children from fourteen states came and stayed for most of the twelve days. A fifty-five page mimeograph report was prepared, mostly on the last two days of camp. It contained seventeen papers, with discussions and five committee reports.

A permanent organization was formed with the intent of meeting at various locations at opportune times. A district meeting was held under the auspices of the C.E. Department of the University of Illinois in March, 1939. The second national meeting was with Case School of Applied Science as host, at Camp Case at Londonville, Ohio, in August, 1940. Professor Dodds presented a paper at each of these conferences.

World War II and the Korean "incident" were the evident reasons for not meeting for a decade. The third national con-

ference was held in 1952 at the University of Illinois and Camp Rabbidau at Blackduck, Minnesota. Professors L. O. Stewart and R. J. Lubsen represented I.S.C. A total of forty-seven summer camps of surveying were reported, a decided increase since the 1937 conference at Brown's Bay. It seems evident that engineering summer camps are steadily gaining recognition as a worth-while part of a C.E. curriculum. I.S.C. may well be proud of its leadership over half a century.

The attendance at each of the second and third national camps exceeded that of the first one with thirty states represented at the third.

The Brown's Bay site was used occasionally for a few years by alumni and faculty and families for summer outings. The place was officially turned back to the Minnesota State Forest in 1951.

Under the leadership of the surveying staff, the C.E. Department and Engineering Extension cooperated in calling a statewide surveying conference on the campus February 25–26, 1930. It drew sixty-six surveyors and county engineers. Annual conferences have been held in the meantime except during war periods with attendance from forty to one hundred fifty (239 in 1954) and continued interest.

In 1947 a separate conference was held by the Engineering Extension Service for county engineers and members of their staffs. This conference has been held each year since then with fairly uniform attendance of around one hundred-fifty. The conferences seem to be well established with high grade programs.

From December, 1933, to July, 1935, the late Professor J. S. Dodds was in charge of about five hundred engineers, surveyors and rodmen who worked on a Civil Works Administration project known as the Iowa Geodetic Survey or the Iowa Topographical and Control Survey. Its purpose was to furnish employment and to do useful work. Many horizontal and vertical control surveys were run, hundreds of control monuments were set, and hundreds of property corners restored. The work was well conceived and executed. It is no fault of the men who did the work that there was no engineering organization in Iowa to take over where they left off. Counties were given the responsibility for preserving the surveys and the monuments. A few counties, for example, Linn, County Engineer Wm. F. Behrens (I.S.C., B.S., C.E., 1920), used the surveys as the basis for a useful county survey and mapping program. In the main, little or nothing was done with the records and the monuments, and they are now of little or no value.

Two significant books in the field of Land Surveying were written by members of the surveying staff. In 1935 Professor Stewart wrote PUBLIC LAND SURVEYS, HISTORY, INSTRUCTION METHODS. (Collegiate Press, now the Iowa State College Press, Ames, Iowa.) This described the early experience of the surveyors and traced the development of original instructions. In 1943 Professor Dodds, Professor Stewart, James McKean '29, and Gerald Tigges '33, wrote ORIGINAL INSTRUCTIONS GOVERNING PUBLIC LAND SURVEYS IN IOWA, A GUIDE TO THEIR USE IN RESURVEYS OF PUBLIC LANDS. (Iowa Engineering Society.) These books have had extensive use by land surveyors.

SERVICE COURSES

Among the courses which have been offered by the C.E. Department for students of other departments and a few offered in other departments for civil engineering students are:

Surveying. Definite service courses in surveying for the foresters and landscape architects have been given since the organization of those curricula. Many geology students have taken these courses. An elementary surveying course (C.E. 325) has been offered for many years. It has been required in some curricula and elected in others.

Drawing. Until the department of drawing was established in 1933, the M.E. Department provided the work in elementary drawing and descriptive geometry for most other departments. Through those years the C.E. Department maintained its own work. Professor Paustian prepared a noteworthy report in 1932.

Materials for all engineering departments from the beginning in 1901 to 1933 when such work was turned over to T. & A.M.

Structures for architectural engineers and architects since those curricula were established. For many years these people have taken the same courses as the civils. The elementary course in structures has been required at times in general engineering and ceramics and elected by others.

Hydraulics. The subject of hydraulics first appeared in the catalog in 1891. It was offered by the M.E. Department as a three hour recitation course. After an early change, it remained four hours until turned over to T. & A.M. in 1933.

Laboratory work in hydraulics was inaugurated by the C.E. Department in 1900. This was also turned over to T. & A.M. in 1933.

The C.E. Department offered a course in hydraulic engineering beginning in 1892. It was a recitation course confined to water-works for a few years, then was extended to include

hydraulic power. The substance of this course was incorporated with other courses in later years.

LIST OF C.E. FACULTY

Table 3 shows an all-time to 1954 alphabetical list of members of the C.E. faculty including graduate assistants. The number is 136. The years in each position are indicated.

Table 3. Civil Engineering Faculty
(by years in each position)

Name	Position					
	Dept. Head	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Grad. Asst.
Agg, Thomas R.* '05 EE; '11 CE	...	15–32	14–15	13–14	...	...
Alsmeyer, William C.	...	...	51–56	46–51	...	...
Ashbaugh, L. E.	...	...	04–07	03–04	...	...
Ayres, James R.	...	...	...	...	...	28–29
Ayres, Quincy C.	...	...	32–33	...	...	...
Banta, Merle H.	...	...	...	...	...	44–45
Baughman, Charles A. '15	...	...	...	17–18	10–17	...
Baumann, E. Robert	...	57–	53–57	...	...	...
Beal, F. E. L.	...	76–82	...	...	...	...
Beard, Vivian D. '09	...	...	...	...	09–11	...
Berg, John	...	...	...	...	05–07	...
Berkel, Howard J.	...	...	...	...	39–46	...
Berry, Donald S.	...	...	...	...	...	31–33
Bird, Byron '12	...	25–26	...	...	...	...
Bobkoff, Kenneth B.	...	...	...	...	50–51	...
Brevik, Berry '18	...	...	...	25–26	24–25	...
Burt, H. J.	...	...	...	00–01	...	...
Carter, Harold S.	...	...	...	...	23–24	21–23
Caughey, Robert A.	...	30–	20–30	19–20	...	...
Chamberlain, Stephen J.	...	...	...	...	...	29–30
Chu, Ting Ye	...	...	...	54–55	...	...
Church, D. W.	...	91–92	...	...	...	...
Cleasby, John L.	...	...	...	56–	54–56	...
Clemmer, Harold F. '12	...	...	...	19–20	17–19	...
Cook, James N. '16	...	...	...	...	20–24	...
Coykendall, Claud C. '10	...	...	...	...	11–13	...
Crum, Roy W. '07	...	...	11–19	09–11	07–09	...
Csanyi, Ladis H.	...	49–	...	...	...	...
Davidson, Donald T.	...	55–	50–55	47–50	46–47	40–42
Davidson, Robert F.	...	...	...	...	...	50–51
Deans, Charles W.	...	...	...	...	...	31–33
Deming, R. M. '08	...	...	...	08–09	...	...
Dixon, Joseph H., Jr.	...	...	...	...	...	48–50
Dodds, John S. '12	...	34–50	17–34	...	...	...
Dragoon, Frank A.	...	...	...	...	13–16	...
Duckering, Charles E.	...	...	...	...	...	29–30
Duckering, William E.	...	19–23	...	...	...	...
Dunagan, Walter M. '23	...	...	...	29–33	24–29	...
Ebling, Everett E. '22	...	...	...	...	25–28	...
Erving, Vere R. '17	...	...	...	...	19–20	...
Evinger, Morris I. '06	...	...	15–17	09–15	06–09	...
Ferguson, Dale L.	...	...	...	...	...	50–51

* Dean of Engineering 1932–'46.

Table 3 Continued

Name	Position					
	Dept. Head	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Grad. Asst.
Finney, Edwin A.	...	...	...	...	...	23–24
Fisher, C. M. '14	...	...	...	...	22–24	...
Ford, Howard Carlton	...	...	11–18	07–11	...	...
Foster, Walter L. '06	...	29–34	21–29	19–21	...	...
French, Frank C. '96	...	...	...	03–07	...	...
Fuller, Almon H.*	20–38	20–57	...	...	...	...
Fung, Hon Pong	...	...	...	55–	53–55	...
Galligan, William E.	...	...	39–53	29–39	26–29	...
Gayer, Richard J. '48	...	...	...	...	48–49	...
Girton, Darrel	...	...	...	...	51–53	...
Godfrey, Norman	...	...	...	...	20–22	...
Gotaas, Harold B.	...	...	...	...	...	28–30
Gray, Harry W. '06	...	...	...	09–11	...	...
Griffith, John H.	...	19–33	...	...	...	...
Harrenstien, Howard P.	...	...	...	...	56–	...
Handy, Richard L.	...	...	...	56–	...	...
Hastings, B. F.	...	...	...	...	17–18	...
Heiple, Loren R. '39	...	...	...	47–48	...	...
Hewes, John W.	...	...	...	19–25	...	...
Hoover, James M.	...	...	...	...	55–	53–54
Hopkins, P. F. '16	...	...	...	...	16–17	...
Hosmer, Wilfred T. '30	...	...	54–	46–54	...	...
Hulsbos, Cornie L. '41	...	57–	53–57	49–53	47–49	...
Jenks, Harry N.	...	...	26–30	...	...	...
Jensen, Emmanuel T. '33	...	...	...	...	48–49	...
Johnson, C.	...	...	...	...	...	04–05
Johnson, Elliott B.	...	...	...	...	48–50	...
Jones, George W., Jr.	...	68–73	...	...	...	...
Kerekes, Frank	...	31–54	27–31	20–27	...	...
King, Everett E.	...	...	11–18	...	...	...
Kirkham, John E.	...	11–19	07–11	...	...	...
Klotz, Frederick E. '21	...	...	...	...	26–32	...
Laguros, Yoakim	...	...	...	...	55–56	54–55
Linger, Don A.	...	...	...	...	56–	...
Logan, John A.	...	...	...	...	35–36	...
Lubsen, Rudolph J. '30	...	...	51–	48–51	...	...
MacDonald, Thomas H. '04	...	...	...	05–11	04–05	...
Mahone, Leslie W. '21	...	...	...	...	21–26	...
Marston, Anson	92–20	92–00	...	...	...	...
Mattern, Donald H.	...	...	...	...	...	26–27
McCasland, William H.	...	...	...	...	...	55–56
McKean, James P.	...	...	...	...	29–31	28–29
Michalos, James P.	...	52–54	47–52	...	...	...
Mickle, Jack L.	...	...	...	...	52–	...
Morgan, Paul E. '44	...	...	...	53–	...	...
Morse, Chauncy N. '23	...	...	...	...	23–25	...
Moss, B. N. '91	...	...	...	92–93	...	...
Mount, Charles F. '78	...	82–91	...	81–82	...	...
Moyer, Ralph A.	...	45–48	33–45	26–33	21–26	...
Murphy, Lindon J. '21	...	...	...	...	21–24	...
Myers, Boyd S.	...	...	...	...	13–17	...

* Professor Emeritus, 1957.

Table 3 Continued

Name	Position					
	Dept. Head	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Grad. Asst.
Nady, Robert M.	...	...	...	55–	52–55	...
Nedderman, Wendell H. '43	...	...	...	...	...	50–51
Neville, C. W. J.	...	...	...	01–02	...	...
Newcomb, Ralph V.	...	...	...	...	21–23	...
Neyenesch, Harry G. '24	...	...	...	...	...	23–25
Nichols, Charles S. '09	...	19–25	17–19	...	...	...
Nigro, Nicholas J.	...	...	...	...	57–	...
Okey, Frank M. '04	...	...	...	...	07–08	...
Oleson, Calvin C.	...	...	...	...	...	26–27
Osborn, Ervin V. '48	...	...	...	...	48–49	...
Oulman, Charles S.	...	...	...	...	57–	...
Patterson, Ralph E., Jr. '46	...	...	...	...	48–49	...
Paustian, Raymond G. '29	...	...	44–47	32–44	31–32	...
Person, Hjalmar T.	...	...	...	...	...	25–27
Pochel, Roy A.	...	...	...	19–20	17–19	...
Poland, Clare A.	...	...	...	...	19–20	...
Porter, A. H.	...	74–76	...	...	...	...
Reinhart, M. J. '05	...	...	...	...	05–07	...
Rollins, Ralph L.	...	...	...	53–55	...	52–53
Scheer, Alfred C.	...	...	...	...	49–50	...
Schlick, W. J. '09	...	49–57	(Deceased Feb. 5, 1957)			
Schmidtman, Edward H.	...	...	...	...	25–26	23–25
Schoen, Robert J.	...	...	...	...	...	52–53
Senne, Joseph H.	...	...	...	54–	...	...
Sheeler, John B.	...	...	...	56–	...	...
Shideler, Robert T.	...	...	...	...	...	24–26
Sieck, Lawrence K. '47	...	...	...	58–	55–58	54–55
Smith, Lowell M. '48	...	...	...	...	48–49	...
Spangler, Merlin G. '19	...	48–	39–48	...	...	...
Stanton, C. B.	...	...	07–11	06–07	...	...
Stegena, Waldo R.	...	...	...	...	...	21–23
Stevenson, J. A.	...	...	...	...	...	25–27
Stewart, J. E. '02	...	...	...	...	04–05	02–04
Stewart, Lowell O. (Deceased Aug. 25, 1957)	38–57	38–	33–38	27–33	24–27	...
Sunley, William B.	...	...	...	...	18–19	...
Swisher, Robert D. '48	...	...	...	...	49–50	...
Taft, Walter	...	...	...	...	49–51	...
Tooles, Calvin W.	...	...	...	...	48–50	...
Upp, Orville T. '21	...	...	...	...	22–23	...
Ustrud, Herbert O.	...	...	56–	51–56	...	...
Van Horn, David	...	...	...	...	55–	54–55
Wallis, Rolland Schanel '07	...	...	...	...	11–17	...
Welden, Neil '25	...	...	...	48–49	...	...–
Wheeler, D. B.	...	...	...	...	08–09	...
Whisler, Benjamin A. '30	...	...	45–46	40–45	36–40	31–32
Williams, Clifford E.	...	...	...	...	21–22	...
Williams, Leroy E.	...	...	...	...	48–49	...
Wilson, Edward N.	...	...	...	...	...	48–50
Wilson, Miss Elmina '92	...	...	...	98–04	...	93–98
Winfrey, Robley '22	...	46–52	39–46	...	...	...
Winn, Harlan	...	...	...	...	39–40	...

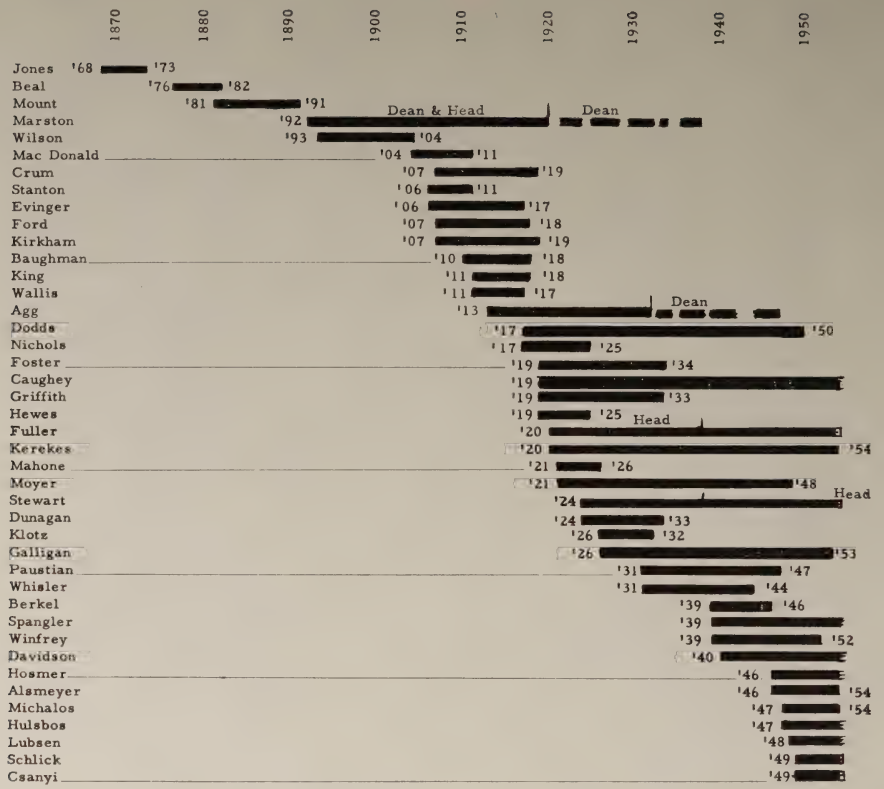

Figure 3. C. E. Staff — five or more years to 1954.

Figure 3 shows in graphic form the years of service of those who have been on the instruction staff for periods of five years or more, to and including 1954.

ALUMNI

A college may be judged from many points of view. The performance of its alumni is certainly one basis for appraising its efficiency. Many appraisals of alumni performance are based upon individual opinion from limited observation. Office records may indicate the location of each alumnus and his general line of work and occasionally contain a note of fact or judgment concerning recognition. Such records, alas, are far from complete.

This chapter points out a few industries and organizations in which I.S.C. alumni have had a leading part in the develop-

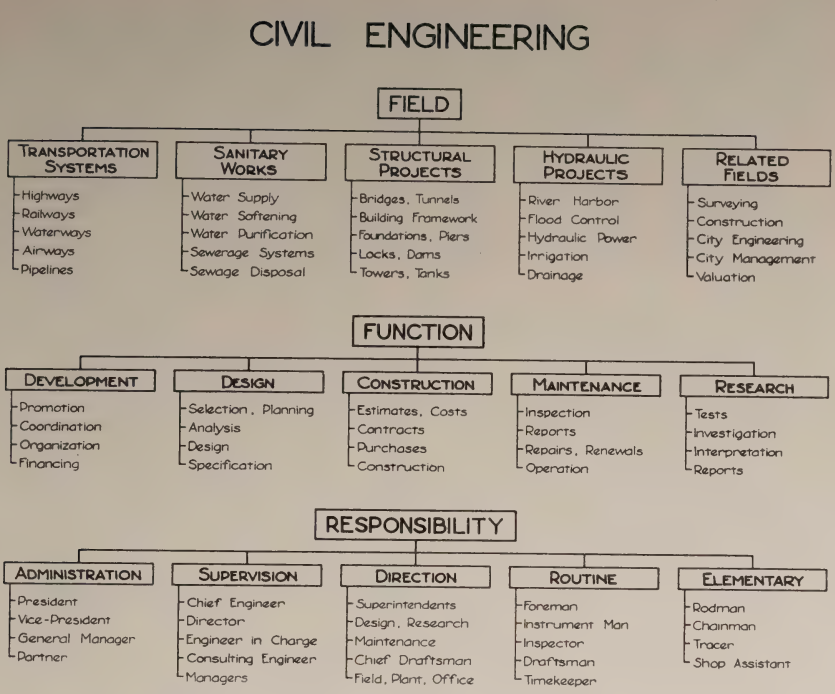

Figure 4. Civil Engineering — Field, Function, Responsibility.

ment. It then, as a rule, leaves to the reader the opportunity of making an appraisal. The section is preceded by a few tabulations and discussion from available information concerning the many phases of civil engineering in which the graduates have found and are finding a life's work.

EMPLOYMENT OF C.E. ALUMNI

No studies are available which include a complete and continuous record of the graduates of Iowa State College. Neither are any available which give, in concise form, such records of U. S. colleges in general.

A study was made in 1955 by the U. S. Bureau of Public Roads by Robley Winfrey* which includes the graduates of U. S. colleges for the departments of Aeronautical, Chemical, Civil, Electrical, and Mechanical Engineering. The study was started in 1941, interrupted during World War II, and has been continued since 1946.

Some of the B.P.R. data are given in table 4 for the 1955 graduates in civil engineering. It includes the type of employ-

* I.S.C. '21. Chief of Personnel and Training, B.P.R.

ment for the civil engineers, with fifty-eight schools reporting. It also includes the I.S.C. data which have been incorporated in the report. The results are stated in percentages of total numbers under twenty-one separate types of positions.

Table 4. Placement in Type of Employment — Percentages

Industry or type of employment accepted	Bureau of Public Roads B. S. Degrees 58 Schools 1955		I.S.C.—C.E. 1955		I.S.C. C.E. 1925–31
1. Business, retail or wholesale	0.24	0	0	0	..
2. Contractors, general & hwy.	4.34	8	5		8
3. Contractors, building	3.38		2	7	
4. Consulting engrg. firms ...	11.41	11	13	13	5
5. Education, tchng. & rsch. ..	1.77	2	..	..	5
6. Education, graduate study ..	4.66	5	2	2	..
7. Gov't., Federal	6.43	6	4	4	8
8. Gov't., St. Hwy. Dept.	10.50	11	20	20	20
9. Gov't., hwy. authorities .... as toll road	0.64		..		
10. Gov't., county	1.61		4		
11. Gov't., city	4.01	7	7	11	7
12. Gov't., other	1.37		..		
13. Manufacturing, air craft ...	5.78		..		
14. Manufacturing, steel	5.14	16	4	15	27*
15. Manufacturing, other	4.58		11		
16. Petroleum & pipe line	4.34	4	..	..	..
17. Railroad companies	1.61	2	2	2	5
18. Utilities, elec., gas, water ..	1.53	2	4	4	5
19. Utilities, telephone	0.40				
20. Miscellaneous or unknown.	8.45	8	5	5	7
21. Military Service	18.55	19	18	18	..
22. Materials	..	..	..	..	4
Total	100.74	101	101	101	101
Public Work					35
Private Work					65
In Iowa					33
Out of Iowa					67

* Includes Mfg. 7, Structural 20.

Table 4 also includes the type of employment of two hundred fifty-four C.E. graduates made in 1931, of the classes 1925–31 which were classified in fewer types of positions than in the B.P.R. study. Comparisons have been made by grouping some of the B.P.R. lines and dropping the decimals.

The information is not sufficiently complete or definite for making precise comparisons. However, a few trends are noticeable:

A. Between the general and the I.S.C. material from the Bureau of Public Roads:

1. Construction (contractors). No marked difference.

2. Consulting engineering firms. No marked difference.
3. Government
   Federal — I.S.C. is slightly less.
   State — I.S.C. is much greater.
   County, City — I.S.C. is greater.
4. Manufacturing. No marked difference.
5. Railroads. No marked difference.
6. Utilities. I.S.C. is greater.
7. Miscellaneous. I.S.C. is less.
8. Military. No marked difference.

B. Between the 1956 and 1931 reports for I.S.C.:
1. Construction. Slight decrease (in 1956).
2. Consulting. More than 100% increase.
3. Government
   Federal — 50% decrease.
   State — No marked difference.
   County, City — Substantial increase.
4. Manufacturing. Decided decrease.
5. Railroads. Decided decrease.
6. Utilities. Slight decrease.
7. Miscellaneous. Slight decrease.
8. Military. None in 1931.

The general pattern of employment is much the same in I.S.C. and the other fifty-seven colleges and in the two I.S.C. studies twenty-five years apart *except*:

A. I.S.C. has a greater proportion than other colleges in state, county, and city government.
B. In late years, I.S.C. has many more graduates with consulting engineering firms and fewer with the Federal government and fewer in manufacturing and railroads.

The 1931 study was followed by another one in 1937, after the main effect of the depression Thirties. Replies were secured from two hundred fifty-one men of the classes from 1910 to 1936. Two distinct analyses were made of the information which was received; one by the department and the other by the editorial staff of Civil Engineering.

Civil Engineering published a page report* and the department based its analysis upon a Field, Function, Responsibility chart which it had made during the previous year. This chart (figure 4) was the basis for some of the questions which were asked of the alumni. The replies are not adapted to the headings of table 4, and therefore are presented separately in table 5.

The number replying represents about twenty-eight percent of the total living men in the classes which were included. The distribution appears to be representative. The sample is interesting and deserves confidence not only as representing the best available information, but as exceedingly good.

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* Nov. 1937, p. 810.

Table 5. Distribution of 251 Alumni, Classes of 1910 to 1936

Field	*Number*	*Percent*
Transportation systems	49	20
Sanitary works	17	7
Structural projects	41	16
Hydraulic projects	20	8
Related fields*	96	38
Outside of Civil Engineering	28	11
Total	251	100
Function		
Development	32	13
Design	43	17
Construction	107	42
Maintainance	28	11
Research	12	5
Miscellaneous, including teaching	29	12
Total	251	100

* Related fields include construction, into which are classified thirty-two men in public construction, mostly with highway commissions. The transportation field, therefore, has absorbed more men than the tabulation suggests.

Anyone who should take the time to read the report in CIVIL ENGINEERING will find difficulty in fitting the data into the headings of table 4. One natural variation is a much greater number in public work, because of the deliberate provision of such work-making bodies as P.W.A., W.P.A., C.C.C., and the State Planning Board.

SELECTED ALUMNI ENTERPRISES

This section will in no way be a directory of civil engineering graduates. The name, address, and position of alumni were given by the IOWA ENGINEER in 1925, 1938, and 1949. Complete professional experiences of many of these men may be found in WHO'S WHO, WHO'S WHO IN ENGINEERING, THE 1912 DIRECTORY OF GRADUATES by C. S. Nichols '10, the 1939* and the 1952† BIOGRAPHICAL DIRECTORY OF I.S.C. GRADUATES by Elizabeth Tiernan, MEMOIRS OF DECEASED MEMBERS, American Society of Civil Engineers, and the engineering press.

A history of a college department cannot be complete without an attempt to appraise the effect of the department, through its staff and graduates, upon the engineering development of the state and the nation. Such an appraisal will be undertaken by tracing the effect of individual alumni upon some of the organizations and groups of organizations which have had a high place in the general development of the country. The organizations which have been chosen are those

* Classes 1872–1889.
† Classes 1890–1899.

in which the experiences of I.S.C. alumni are available.

The temptation has been great to use many names of men and of organizations. That temptation has been resisted as a rule because of the impractibility of securing the necessary information for a complete list of enterprises which have been developed primarily by I.S.C. alumni or to make an adequate balance in recognition and in historical value. In the use of names, preference has been given to the older men, whose work has been established and who have built up organizations and principles which have lived and have been widely recognized. The assumption has been made that the reader will accept the situation that the attempt is to portray the college and the department through the alumni rather than to give emphasis to the individual or to an organization.

SANITARY ENGINEERING

The need for investigations in the field of sanitary engineering was early recognized by Anson Marston. Papers by him and others were presented to the Iowa Engineering Society, the Iowa Academy of Science, and the Western Society of Engineers, Chicago, during the years 1900–3. Those papers and others were published at the time and reprinted later by the College. After the founding of the Iowa Engineering Experiment Station in 1904, the early papers were recognized by the I.E.E.S. and the numbering of its bulletins included them. The initiative for the early papers and also the beginnings of the I.E.E.S. was clearly taken by the civil engineering staff, that is, by Anson Marston.

The first five bulletins of the Iowa Engineering Experiment Station, 1900–1902 were devoted to sewage disposal. Many later ones discussed the various phases of sanitary engineering. Number one is in three parts: The Iowa State College Sewage Disposal Plant and Investigations by A. Marston. The Chemical Investigation of the College Sewage Plant by J. B. Weems. Bacteriological Study of the Ames Sewage Plant and Some Iowa Water Supplies by L. H. Pammel.

The first bulletin, 1900, suggests an early beginning of departmental cooperation in research work. Such cooperation has continued to be a strong factor. It also sets a standard for timeliness and thoroughness. One of the introductory statements, p. 5, is: "By the investigations which are being conducted at Ames it is hoped, first, to obtain the data needed for the design and operation of sewage disposal plants under Iowa conditions, and second, to add something, if possible, to the general stock of knowledge regarding sewage purification."

Bulletins 1–5, 1900–1902, all record the results of the behavior of the college disposal plant. One of them, No. 3, includes results from sewage flow at Des Moines, Grinnell, Marshalltown, and the State of Iowa "Hospital for the Insane" at Mount Pleasant, with further data from the college disposal plant. The information for Bulletin 3 concerning the amount and quality of sewer effluent was an excellent basis for further design of disposal plants in the state.

Of our early bulletins, nine of the first twenty-four, and twelve of the first sixty-two were in the sanitary field.

A statement has often been made that Anson Marston designed the first sewage disposal plant west of the Mississippi River. Definite information to establish the statement does not seem to be available. There is much to prove that he was active and competent in the field before the turn of the Century and later. Bulletin No. 1 states that he made the design for the college plant during the winter 1895–96; that the legislature soon made an appropriation for the construction; that the plant was built and in operation in 1898.

The files of the C.E. Department include a few tracings of designs for sewage disposal plants which contain the name of Anson Marston and a 1904 date. Other tracings, without his name, but drawn by others between 1904 and 1910 have also been kept.

His appointment as a member of the Engineering Board of Review, Sanitary District, Chicago, 1924–25, and as a consulting engineer on sewage for Miami, Florida, 1925–27 shows a continued recognition in the sanitary engineering field. Similar recognition is indicated by appointments to the Florida Everglades Engineering Board of Review, 1927; as civilian member of the Mississippi River Board of Review, 1932–33; Inter-Oceanic Board to advise on Nicaragua Canal and enlargement of Panama Canal, 1929–32; member of National Research Council, 1919.

Later activities in the sanitary engineering field have included a number of researches under the Engineering Experiment Station. Much of the technical direction has come from efficient cooperation between the departments of Bacteriology (Buchanan, Levine) and Civil Engineering (Marston, Nichols, Galligan, Jenks, and Baumann.) The subjects have included sewage disposal for village and rural homes, Iowa industries and municipalities; creamery wastes; beet sugar wastes; packing

house wastes; and the water supply, sewage disposal, and design of municipal swimming pools.

In addition to the foregoing, a number of other phases of sanitary engineering have received attention, notably an investigation of hydraulic characteristics of sewer manhole floors. This project has drawn wide attention as a definite contribution to the economic and the satisfactory behavior of the flow in sewers. It has, and should continue to have, a satisfying effect upon the taxpayer's dollar.

Dean Marston's interest in sanitary engineering reached also into water supply and into the sanitary control of the water in Lake LaVerne. In meeting the needs of the College in each of those lines, he, incidentally, erected a monument. The water tower, which is still an attractive land mark as well as a reservoir for water supply, was designed by him and erected under his supervision in 1897. Lake LaVerne, first constructed in 1917 and cleared of sediment and provided with the overflow channel for flood waters in 1933, adds much to the charm of the campus of Iowa State College.

The twenty year outlook for research in the sanitary engineering field was made in 1935 in The Twenty Year Development Program. A list of research projects in sanitary engineering was given on page 39. Of the seven main topics and seven sub-headings, all but main topic (c) has been given definite consideration by Professor W. E. Galligan with the assistance of Professor B. J. Whisler '30, numerous graduate students, and superintendents of the College physical plant, Perry LaRue, Boyne Platt and Ben W. Schaefer. No formal bulletins or magazine articles have been prepared, but a number (perhaps a dozen) papers have been presented before various organizations including Iowa Sewage and Industrial Waste Association, Iowa section of American Water Works Association, Iowa section of the A.S.C.E., Iowa Engineering Society, and the Iowa Canners' Association.

The men in sanitary engineering have cooperated with Engineering Extension Service in conferences on sewage disposal, primarily for sewage disposal operators. Twenty bulletins in the sanitary engineering field have been issued. Early ones by A. Marston and C. S. Nichols were followed at intervals by L. W. Mahone '20 in the late Twenties, W. E. Galligan through the Forties and by E. R. Baumann since 1954.

UNDERGROUND CONDUITS INVESTIGATIONS FOR LOAD AND STRENGTH

Underground conduits have been in use for the flow of water and sewage since the early ages. Culverts have been built for a long time to carry a highway or a railway over other roads or small streams. The sizes of the openings were based upon observation and experience. The strength factors were even more empirical. The science of hydraulics became the source of analyzing carrying capacity of these structures in the Nineteenth Century.

The need for investigations for the strength of underground conduits had not been generally recognized. As far as records show, Anson Marston was the first to see the problem and to do something about it. He early saw two important factors in the problem: 1. The load the pipe must support, and 2. the dimensions and characteristics of the pipe to support that load under the unfavorable conditions that usually exist.

The first publication, Bulletin 31, was THE THEORY OF LOADS ON PIPES IN DITCHES AND TESTS OF CEMENT AND CLAY DRAIN TILE AND SEWER PIPE, 1913, Anson Marston and A. D. Anderson ('05 Mining Engineering). It contains one hundred seventy-seven pages. The pilot tests which were included indicated the possibilities of such tests and paved the way for the extensive researches which followed. The recognition of the theoretical analysis increased as further investigations were made. Bulletin 31 has long been considered a classic and has been in demand around the world. Many have been astounded as their tests over a wide field have shown a remarkable conformation to the Marston theory.

Bulletin 31 was followed in 1917 by No. 47, THE SUPPORTING STRENGTH OF SEWER PIPE IN DITCHES, AND METHODS OF TESTING SEWER PIPE IN LABORATORIES TO DETERMINE THEIR ORDINARY SUPPORTING STRENGTH, by A. Marston, W. J. Schlick '09 and H. F. Clemmer '12.

The leading spirits in the entire conduit field were Marston and Schlick in the early years, ably reinforced by M. G. Spangler '19 in the early Twenties.

The continuing work since the Twenties has included: The transmission of static and impact loads to culverts from trucks and other heavy loads (Bulletin No. 79, 1926, Spangler, Mason and Winfrey); rigid and flexible supporting structures (Bulletin No. 112, 1933, Spangler, and No. 153, 1941, Spangler); load on pipes in wide ditches, including vertical and inclined sides

(Bulletin No. 108, 1932, Schlick); the measured load on pipes with negative projections (imperfect ditch or ditch with depth less than the diameter of the pipe); (Proc. Highway Research Board, 1952, Schlick, and I.E.E.S. Engineering Report No. 14, 1952–53, Spangler and Schlick); and horizontal pressures on retaining walls due to concentrated loads (Bulletin No. 140, 1938, Spangler).

In addition to those on experimental researches, two more bulletins have appeared. They were written by Professor J. H. Griffith who became a member of the C.E. staff in 1919 and in 1934 was transferred to the T. & A.M. Department and later to the Engineering Experiment Station staff. These Bulletins, No. 101, Physical Properties of Earths, 1931, and No. 117, Dynamics of Earth and Other Macroscopic Matter, 1934, supplement the earlier theoretical studies and indicate the application of the well-known Boussinesq theory of earth pressure to certain situations in the conduit field.

The older alumni will recall the beginnings of the conduit (frequently called culvert) tests on the site of the present Hughes Hall (near the Marston home) and north and west of the heating plant. After Marston had returned from World War I (as Colonel of Engineers), the investigations were continued at the present (1954) sites at the northeast corner of Thirteenth Street and Stange Road. This site is visited occasionally by engineers from all over the world who have recognized the value of the many investigations which have been made there.

Suggestions for further knowledge of the behavior of underground conduits have come from many sources including engineers with responsibilities in land drainage, municipal sewerage, municipal water supply, highway and railway culverts, water and gas distribution systems and high pressure gas lines. A paper on the latter topic by Professor Spangler appeared in The Petroleum Engineer for November, 1954.

In addition to the work on the campus, I.S.C. faculty and alumni have been active and influential in making applications of the theoretical and experimental work on conduits and drainage by serving on committees of various engineering societies, including A.S.C.E. and A.S.T.M.

Publications in the underground conduit field include the fifteen Bulletins and two Engineering Reports of the Iowa Engineering Experiment Station and other articles in the publications of engineering societies and in the engineering press.

LAND DRAINAGE

The magnitude of the drainage problem for Iowa and the Nation was early indicated in Chapter 1, Bulletin No. 31, of the Iowa Engineering Experiment Station. "The tile drainage of Iowa is only fairly begun, yet the Governor of the state, in his 1911 inaugural address, has quoted estimates by county officers familiar with Iowa drainage that about 125,000 miles of tile drains have already been constructed on Iowa farms, enough to reach five times around the entire world." (p. 11)

"... in the case both of cement and clay tile, we have, for drains of fifteen to forty-four inches diameter, the extensive use of *tile in sizes so unprecedently large* that the tile have never before been tried out under actual field conditions of use, to determine by experience the strength necessary to sustain the loads to which they must be subjected in the ditch." (p. 13)

"It is full time to develop a correct method for calculating the actual load on pipe in ditches; to develop and generally adopt a standard method for testing drain tile and sewer pipe; to adopt fair and adequate standard specifications for the quality of drain tile and sewer pipe, as indicated by standard tests; and finally, to subject drain tile and sewer pipe to tests as generally and as faithfully as is now practiced with steel, paving brick, and cement." (p. 12)

These quotations suggest the authors' grasp of the magnitude of the economic factors and the necessity for definite technical information.

The second and third quoted paragraphs refer to the necessary strength of the pipe. Bulletin No. 31 is devoted primarily to the strength phase. This phase is discussed on the following pages under a separate heading.

The first quoted paragraph from Bulletin No. 31 refers to the magnitude of the need for the drainage of land. The need consisted of four parts:

1. To determine when drainage was necessary.
2. To determine the spacing of drains or conduits.
3. To determine the sizes of the conduits.
4. To determine the strength of the conduits.

Part 4 is included in the general discussion on underground conduits.

Much work in the drainage field has been done through the years by alumni, either as engineers for an organization or as consulting engineers. The facts and the principles which have been developed for drainage have also been of much value in flood control and in irrigation.

HIGHWAYS

Iowa State College may well point with pride to the achievement of its alumni and faculty in the highway field. Superlatives may safely be used in the appraisal of the accomplishments.

Two recent books* furnish the material for a quick background of early transportation problems. They go from ancient roads and Indian trails through Colonial post roads to the Turnpike Era during the first half of the Eighteenth Century. The Lancaster Turnpike from Philadelphia to Lancaster, Pennsylvania, is given as the first macadamized road, and the date as 1792. In 1806 the U. S. Congress authorized a great national highway to connect the Ohio Valley with the seaboard. It was to start at Cumberland, Maryland, which was already connected to Baltimore by a "turnpike," and proceed northwest somewhat along an old Indian trail. It reached Wheeling, West Virginia, in 1818 and was subsequently extended to Illinois. It was a great artery of travel and commerce before the days of railroads and canals. This highway has been known as the Cumberland Road and as the National Road. The present U. S. 40 follows the general route of the old Cumberland Road.

At the time of the formal opening of I.S.C., March 17, 1869, the roads throughout the state and much of the nation had barely passed from the Indian trail stage into roads of dust and mud. These in central Iowa are graphically described by Mrs. Gladys Hultz Meads in her recent (1954) historical sketch of Ames, The Skunk and the Squaw. No record has been available concerning the participation of faculty, students, or alumni of the College in the establishment of these early roads.

Anson Marston became a member of the staff in 1892. Thesis subjects on the road situation soon began to appear. The advent of the bicycle in the Nineties and the automobile after the turn of the Century quickened the need of better roads throughout the country. Professor Marston, with his usual foresight and understanding, recognized a need and an opportunity. The Iowa Legislature, in 1903, passed the necessary legislation and made a modest appropriation for the establishment of the Iowa State Highway Commission. The sum of $3,500.00 was to be administered by the Dean of Engineering and the Dean of Agriculture of Iowa State College. That meant, at the time, Anson Marston and Charles F. Curtiss.

Bulletin Volume II, No. 6, Iowa Engineering Experiment Station, June, 1905, by A. Marston, C. F. Curtiss and T. H.

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* Highways In Our National Life, Labatut and Lane, 1950. Highways Of The Past, 2 Vols., Albert C. Rose, 1952.

MacDonald, was evidence of the early grasp of the highway problem and the thoroughness with which it was attacked. It is interesting reading now after half a century.

More than twenty highway bulletins have since been issued by the Station.

National. Newspapers and engineering publications throughout the land, and more or less throughout the world, announced in 1953 the retirement of Thomas H. MacDonald '04 as U. S. Commissioner of Public Roads (deceased, 1957). They refer to him as "Mr. Highway"; "The No. 1 Highway Engineer of our Times"; "The World's Foremost Highway Engineer"; etc. They quote Mr. MacDonald in a recent interview: "The highway engineer's problem is that he be permitted to accomplish the things he knows how to do. Before he can plan or build better highways, legislators must provide the administrative machinery and the source of funds."

An analysis of Mr. MacDonald's numerous appearances before state legislatures and the U. S. Congress definitely establishes his ability to gain congressional confidence and get continued legislative support. He has also had very general support of the highway departments of the various states by asking for cooperation without attempting dictation. He has respected the policy of states' rights while securing the necessary Federal direction for a truly National system of highways.

Mr. MacDonald's first expressed interest in highways, as far as we know, was in choosing a graduation thesis in that field after a conference with Anson Marston, then head of the department of Civil Engineering. Later Professor Marston secured his appointment as Assistant Professor of Civil Engineering in charge of road investigations and in 1907 as State Highway Engineer. His outstanding success in Iowa was a natural stepping stone to the national field in 1919 as Chief of the Bureau of Public roads.

A sufficiently great tribute has not yet been written concerning his leadership in interpreting the need of the national highway system, including "state aid," in developing an organization to meet that need, securing a high degree of support in the various states, and thereby gaining national recognition and approval. The fact that his recognition goes beyond national boundaries is attested by the various decorations from foreign governments.

Another outstanding alumnus in the national field of highway development was Roy W. Crum '07. At the time of his sudden death in 1951, he had been for more than twenty years

the Director of the Highway Research Board of the National Research Council.

Mr. Crum went with the Pennsylvania Railroad immediately after graduation. He was recalled to Iowa State College within a year as instructor and later became Associate Professor of Civil Engineering and Structural Engineer for the Iowa Engineering Experiment Station. His researches on the use of local gravel on Iowa roads proved to be of great economic and practical value.

In 1919 the Iowa Highway Commission created the position of Engineer of Materials and Tests and secured Mr. Crum to develop a program. Again his researches, with understanding applications, gained wide recognition in Iowa and elsewhere as outstanding contributions to highway development.

His selection in 1928 as Director of the Highway Research Board was a natural one. He and Mr. MacDonald developed a high degree of cooperation in maintaining a liaison between the organizations responsible for the development of and use of necessary materials. Each called upon many I.S.C. men.

Thomas R. Agg was widely known as an excellent teacher in the Civil Engineering Department, an efficient Dean of Engineering, the author of pioneer books in the highway field and as a useful citizen. He graduated in Electrical Engineering, I.S.C. '05, and began to work with the General Electric Company at Schenectady, New York. Advised by his physician a little later to keep out of doors for a year, he secured a field position with the Illinois Department of Highways. He was one of the men who early caught the vision of highway development and decided to make that development his life's work. He received our C.E. degree in 1911 and became a member of the C.E. staff in 1914.

Among the noteworthy discussion in his books was the development of an economic theory of highway location, an extension of Wellington's, "The Economic Theory of Railroad Location," in 1887. He was recognized as a worthy colleague with Marston, MacDonald, and Crum in developing the Highway Research Board and the highway field in general.

Iowa State College also had other connections with the Highway Research Board. On October 8, 1919, Anson Marston and Professor A. N. Talbot of the University of Illinois, members of the Executive Committee of the Engineering Division of the National Research Council, met in Chicago with Thomas H. MacDonald, B.P.R., and Clifford Older, President of the Mississippi Valley State Highway Department Association, and

took the initial steps for the formation of the Advisory Board on Highway Research of N.R.C. which later became the Highway Research Board. Dean Marston was the first chairman. Later I.S.C. chairmen of the Highway Research Board were: T. R. Agg, 1926 and 1927; R. A. Moyer, 1950 and 1951; W. H. Root, 1954 until his death in 1954.

Iowa. After Mr. MacDonald was called to direct the U. S. Bureau of Public Roads in 1919, F. R. White '07 became Chief Engineer of the Iowa Highway Commission. Mr. White had been continuously with the commission since 1911 and had a big part in carrying into effect the policies which had been developing through the years. He retained the former staff and rearranged them as follows:

F. R. White '07–53, Chief Engineer
C. C. Coykendall '10, Engineer of Road Management
W. E. Jones '13, Engineer of Road Surveys and Plans
F. H. Mann, Engineer of Road Construction
W. H. Root '11, Engineer of Road Maintenance
J. H. Ames "11. (City Manager of City of Ames, 1927–1953), Bridge Engineer
R. W. Clyde, Drainage Engineer
R. W. Crum '07, Engineer of Materials and Tests
Robert McCormick '10, Engineer of State Parks and Institutional Roads
Alda H. Wilson '94, Superintendent of Women's Drafting Department

Long before his retirement in 1952 Mr. White was recognized as one of the country's outstanding chief engineers. He not only "got Iowa out of the mud' but had an important part in the development of the American Association of State Highway Officials. This association formed a crucial link in securing cooperative action among the U. S. Bureau of Public Roads and the highway departments of the various states. Many I.S.C. alumni throughout the country have been active in this organization.

The intervening years have brought many changes in personnel and in standards in the Iowa State Highway Commission. It is not the purpose of this paper to record the changes, but the first list in personnel after John G. Butter became chief engineer was:

John G. Butter, Chief Engineer
W. H. Root, '11, Deputy Chief Engineer
Mark B. Morris, '21, Director of Research

John F. (Jack) Reid, Administration Engineer
R. C. Boyd, '24, Maintenance Engineer
Fred C. Schneider, '15, Design Engineer
W. O. Price, '08, Safety and Traffic Engineer
Bert Myers, '17, Engineer of Materials and Tests
L. M. Clauson, Ex '24, Secondary Road Engineer
C. L. Gleason, '17, Construction Engineer
K. L. Hart, Auditor

Mr. Root served only a little over a week, when he was stricken by a heart attack from which he died about two weeks later. L. M. Clauson was promoted to Deputy Chief Engineer, effective June 1st, and R. E. Merrill was promoted to Secondary Road Engineer, effective the same date.

The many references to Iowa's leadership in its road program suggests a very high recognition of I.S.C. men. In the state's highway development, these men, during the first half of the Twentieth Century, received training and inspiration in the highway field chiefly from Anson Marston, Thomas R. Agg and Ralph A. Moyer, and more recently from Ladis H. Csanyi.

Nineteen bulletins and one Engineering Report have been published.

The influence of I.S.C. graduates in the highway field has not been confined to the national program and to Iowa. In other states, many men have been in key positions.

In December, 1952, a conference on highway engineering was called by Engineering Extension with the cooperation of the C.E. staff. This conference was organized into six sections. Several section meetings have been held each year in the meantime, occasionally with two or more sections at a time. Attendance has varied from twenty to eighty; the project seems to have made a place for itself.

HYDRAULIC DREDGING

Hydraulic dredging is a special form of excavation and construction with two major steps: (1) underwater excavation, and (2) the building of embankments and other filling of land by use of the material which has been dredged. The fundamental process which is peculiar to hydraulic, or suction, dredging is the transportation of excavated material by a stream of water through a pipe line.

Iowa State College alumni have had an important part in the development of dredges, their use, and general harbor development. The records reveal an interesting relationship

among various companies and the influence of I.S.C. alumni in these inter-relationships. George W. Catt '82, J. C. B. Lockwood '85, and L. T. Gaylord '04, will go down in history for outstanding accomplishments in the development of the science and art of dredging and the formation and direction of dredging organizations. Many other alumni have found their life's work in the hydraulic dredging field. Younger men are now gaining recognition.

George W. Catt '82* is frequently referred to as the daddy of hydraulic dredging. Early in his career he became a competent construction man and worked into dredging, very naturally, as a new type of construction.

He went with the King Bridge Co., Cleveland, after graduating and built bridges throughout the Midwest. His headquarters was Des Moines, Iowa, for three years. In 1885, he was sent to San Francisco for the company and came into competition with the San Francisco Bridge Co. whose president was John McNullen. McNullen induced Catt to come with him as Chief Engineer. In 1889 the San Francisco Bridge Co. opened a Seattle office for the company with Catt in charge. The Seattle fire, a little later, opened the opportunity to take a leading part in the reconstruction of the docks and sheds. After a couple more years of strenuous work, including the building of ninety miles of railroad along the Coeur d'Alene River for the Great Northern Railroad, he went to Boston on a vacation trip. He was attracted by a request for bids for hydraulic dredging in Boston harbor and decided to satisfy his curiosity by submitting a bid. The awarding of the contract gave McNullen and him a challenge which placed them firmly in the dredging business. The eastern business was reorganized in 1892 as the New York Dredging Co. with Mr. Catt as president. This was succeeded by the new and larger Atlantic, Gulf, and Pacific Co. in 1901 with Mr. Catt as president and chief engineer.

In 1901, the A.G. & P. Co. obtained a contract for dredging the harbor at Manila, P.I.; Mr. Catt assumed direct charge and built a dredge, the *Manila*. He later secured contracts for a coaling station and other improvements in Manila harbor. In addition to outstanding ability, the A.G. & P. biographer refers to him as having "singular sweetness and grandeur of character."

Mr. Catt died suddenly in 1905. A two thousand word

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* Data primarily from biographical records of Atlantic, Gulf, and Pacific Co. Engineering News, Vol. 54 (1905), p. 384. 1912 Engineering Directory.

tribute including many details of his unusual experiences appeared in Engineering News, Vol. 54, (October 12, 1905), p. 384. The article was reprinted in the 1912 Directory of I.S.C. Engineering Graduates. His personal library, with many reports and photographs, is now a part of the I.S.C. Engineering Library. His wife, Carrie Chapman Catt '80, up to the time of her death in 1947, would frequently visit the library to see the Catt collections. Mr. Catt had turned over to his wife much of his personal profits from dredging enterprises for use in her noteworthy campaign for women's suffrage. He left an endowment of $100,000.00 to the College for loans to worthy students. This was more than doubled by Mrs. Catt after his death in 1905.

Mr. J. C. B. Lockwood '85*, after preliminary experience with the Chicago Forge and Bolt Co. and the Berlin Iron Bridge Co., joined the staff of the San Francisco Bridge Co. in 1889. He went to Seattle the same year with Mr. Catt to open a branch office of the San Francisco Bridge Co. He became manager of the office after Catt left a couple of years later (1887). For a decade the work included bridges, ships, and dredging operations. In 1898 the company was reorganized into the Puget Sound Dredging Co. with Mr. Lockwood as President and Chief Engineer. He was in Washington, D. C., a part of 1900–1902 in charge of the construction of a hydraulic dredge for Mr. Catt for the Atlantic, Gulf, and Pacific Co., an affiliated company.

Mr. Lockwood apparently was the first man to use a hydraulic dredge for the construction of an earth-filled dam. The first dam so built was at Maybelle, Texas. He was the originator of the swivel joint for the stern of pipe line dredges and other devices which proved to be important in hydraulic dredging.

After returning to Seattle in 1902, he severed his connection with the companies and established a consulting practice. He was busily occupied for a couple of decades on design and construction of harbors, docks and dredging. Much of this work was for the city of Portland where he lived several years.

He returned to Seattle in 1919. Among his clients was the Puget Sound Bridge and Dredging Co., successor to the Puget Sound Dredging Co. At that time, S. H. Hedges '86 was president of the Puget Sound Bridge and Dredging Co. Mr. Lockwood designed a dredge for that company as late as 1944. He died December 2, 1945.

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* Memoir Trans. A.S.C.E., Vol. LI (1948) p. 1947.

Laurence T. Gaylord '04 was brought into the Atlantic, Gulf, and Pacific Co. in June, 1904, by Mr. Catt. His first assignment was to Savannah, Georgia. His first job was clerk and engineer on the dredge *Florida*. The project was the deepening of the Savannah River. He lived on the dredge. This was important both for the immediate task and for the opportunity of observing the performance of a dredge. Such experience furnishes a highly desirable background for later work in operation and administration.

A year later, Mr. Gaylord was summoned to the New York office and was assigned to Philadelphia as inspector for a new dredge, the *New York*. He saw Mr. Catt for a few minutes and was asked to return and go to lunch with him. In the meantime Mr. Catt was stricken and never returned to the office. Mr. Gaylord sadly went to Philadelphia. The *New York* was renamed the *George W. Catt*. The *Catt* is still in operation with the improvement of the Houston ship channel and the straightening of the Mississippi River as two of her major activities. This dredge has been repowered and improved from time to time and is even today known as one of the best dredges in the business.

The Houston project has been an intriguing one over many years, including early construction, maintenance and enlargement. A complete story would be of interest to many, but its length precludes its use for this purpose. A necessary part of this story is that it includes a notable contribution by I.S.C. alumni. Mr. Gaylord apparently is the one who has carried the major responsibility and has contributed to many technical problems. He was in direct charge of most of the early work from 1912 to the completion of the initial contract in 1914. At that time, he transferred to the New York office as director and vice president in general charge of all of the work of the company. As president from 1945 to 1954 and even since, as chairman of the board, he has found time to keep in touch with the Houston work.

Mr. Gaylord was instrumental in bringing into the company several alumni, including: Paul B. Miller '06, who remained until retirement in 1949 when he was Southern manager in charge of work on the Gulf of Mexico. S. H. Ware '09, who was general superintendent on the Gulf from 1914 to his death in 1948. Rowland R. Manatt '21, after apprenticeship on a dredge, became engineer, assistant manager, manager (1949) and vice president and director (1954). He has general charge of all work

on the Gulf and on the Mississippi River. Henry F. Schoon '24, who started as engineer at Port Arthur, Texas, in July, 1924, later became dredge superintendent, and in November, 1945, vice president and director. In February, 1953, he became executive vice president and in February, 1954, was elected president. He has also been vice president and director of North Atlantic Dredging Co. since 1945.

Mention has been made of the fact that Mr. Catt was consulting engineer and vice president of the Puget Sound Bridge and Dredging Co. of Seattle at the time of his death October 8, 1905. Samuel H. Hedges '86, became president on January, 1904.

On January 1, 1905, R. M. Dyer '91 M.E. came into the Puget Sound Bridge and Dredging Co. as plant expert and mechanical engineer and remained until his retirement in 1922. Mr. Hedges retired as president in 1928. He died in Seattle, June 28, 1944.

(The writer was a resident of Seattle from 1898 to 1917 and became well acquainted with Mr. Hedges and Mr. Dyer. They gave him his first and very favorable impressions of Iowa State College. Mr. Hedges seemed to be much impressed with a young man on the civil engineering staff, Anson Marston. The writer also met Mr. Lockwood a few times and remembers him as an able and courteous man who was generally accepted as one of the country's leading designers of dredges and of harbors.)

Mr. Hedges was succeeded as president in 1928 by Roy E. Miller '10, who first came with the company in 1910, was general manager in 1924 and vice president in 1927. Mr. Miller severed his connection with the company in 1929.

The next president (apparently) of the Puget Sound Bridge and Dredging Co. (and the present one, 1957) was H. W. McCurdy, a student of the University of Washington at the time the writer was on the faculty there. His interest in I.S.C. and its men has been apparent in many ways. An example of his interest was noticeable at the time of the death of Charles Edaburn '26, in 1937. He wrote to the College, telling of Edaburn's outstanding work as superintendent of construction and saying he considered him the best construction man he knew. He asked the privilege of sending to the College a photograph and a copper plaque in his honor. The photo and the plaque were installed in Room 313, Marston Hall, after approval by the dean and the president. After the C.E. Department moved

to the Engineering Annex Building, the photograph and plaque were moved to Room 216 in that building. They have served as an inspiration to our students.

Ernie Harris '06, Frank Knowles '09, and W. E. Buell '11 were with the Puget Sound Bridge and Dredging Co. for several years. Mr. Harris was chief engineer for a time. He was an uncle of Thomas H. MacDonald '04 and roommate of Roy E. Miller '10 for one year.

STRUCTURAL ENGINEERING

The design and construction of bridges and buildings were early recognized as a necessary part of the curriculum. Many of the alumni were attracted to that field upon graduation. The work in general has been with established companies, the bridge departments of railways and highway commissions, with cities, and with or as contractors and consulting engineers.

The materials most used have been timber, wrought iron, steel (after the 1880's), and concrete. Precast, prestressed and post stressed concrete are recent terms which structural engineers will find interesting, stimulating and helpful. A few of the alumni have taken the initiative in the organization and management of structural companies.

Pittsburgh-Des Moines Steel Co. Two C.E. alumni of the Class of 1891, William H. Jackson and B. N. Moss, formed a partnership of Jackson and Moss, waterworks engineers and contractors, in 1892 with a capital of $500.00, which later became the Pittsburgh-Des Moines Steel Company.

After graduation, W. H. Jackson served as an instructor in mathematics and B. N. Moss served as instructor in civil engineering at Iowa State College.

The next year Mr. Jackson accepted a position as town engineer in Fort Madison, Iowa, and became interested in the installation of water works systems, and interested his classmate, B. N. Moss, in forming a partnership. In the Fall of 1892 their first job as consulting engineers for the town of Boone, Iowa, was to design, lay out and prepare plans and specifications for a water system. They were granted their request to be allowed to bid as contractors on the installation of the work. They were low bidder and were awarded the contract.

In the course of other work which resulted from the successful completion of their first jobs, Jackson and Moss designed steel elevated water tanks for which they purchased steel from a Pittsburgh firm called Keystone Bridge Company (later to become a part of the American Bridge Company, a subsidiary

of U. S. Steel). In 1900 E. W. Crellin, who had a small fabricating shop in Des Moines, joined the Jackson and Moss partnership and a new corporation was formed, the Des Moines Bridge and Iron Works, with Mr. Crellin as president, Mr. Moss as works manager and Mr. Jackson in charge of engineering and sales.

Mr. Moss retired in 1912 and his two partners bought his share of the business. In 1917 the name of the firm was changed to Pittsburgh-Des Moines Steel Company. Mr. Crellin retired from the business in 1922, and Mr. Jackson became president of the company.

Upon the death of W. H. Jackson in 1939, his eldest son, J. E. Jackson, class of 1924, who had been with the company since 1920, was elected president and has served in this capacity ever since.

From the first water tanks and towers, some of which still stand today, the business of the company grew to the fabrication of reservoirs and storage tanks, pressure and vacuum spheres, elevated steel tanks, incinerators, swimming pools, grandstands, bridges, industrial buildings, wind tunnels, penstocks and miscellaneous structures.

The company maintains a fellowship at Mellon Institute of Industrial Research in Pittsburgh.

Through its charitable trust, the company contributes support to numerous educational and welfare institutions.

In 1913 another classmate of W. H. Jackson and B. N. Moss, George L. Christy, joined the company and served as head of the engineering department until his death in 1950.

Walter W. Hendrix, class of 1903, joined the company upon his graduation and continued as sales manager until his retirement in 1951.

James O. Jackson, class of 1927, nephew of William H. Jackson, is now vice president and chief engineer and a member of the board of directors. In June, 1956, J. O. Jackson was awarded the Anson Marston Medal at Iowa State commencement exercises in recognition of achievement in engineering.

John E. O'Leary, class of 1910, was sales manager, vice president and member of the board of directors until his retirement in 1955.

C. A. Fegtly, class of 1925, architectural engineering, is manager of the Santa Clara, California, branch and a vice president.

W. B. Sargent, class of 1939, is assistant to the chief engineer at Pittsburgh.

M. J. Hillman, class of 1929, is manager of the erection department of the Des Moines branch.

Other C.E. graduates of Iowa State College who have been with the company for several years are: Gerald Derr '41, J. R. Foster '44, Robert W. Jordan '46, F. L. Maine '43, J. C. Robinson '29, R. E. Stenstrom '20, and F. C. Warrington '37.

The company has plants and offices in Pittsburgh, Des Moines, Santa Clara, Newark, Chicago, Dallas, Seattle, Sacramento, Stockton, Fresno, El Monte, Cadiz and Madrid, Spain.

The Des Moines Steel Company. The Des Moines Steel Co. at Des Moines was founded in January, 1916, by John Edgar Van Liew, EE '99, C.E. '01, Professional Civil Engineer '07. Mr. Van Liew's previous work included about fifteen years of well-rounded experience with railroads and structural steel fabricating companies.

He soon added to his staff Stewart Witmer '09, who had been with him as erecting engineer with the Des Moines Bridge and Iron Co. (Now Pittsburgh-Des Moines Steel Co.) Mr. Witmer has been with the Des Moines Steel Company continuously. He is now in charge of the bridge department.

Robert M. Bleakley '22 joined the staff upon graduation and is now chief engineer.

Chicago Bridge and Iron Company. The Civil Engineering Department of Iowa State College has long known the Chicago Bridge and Iron Company as an organization with which many of the graduates have found invaluable experiences over many years. Recent studies have brought to light the fact that I.S.C. alumni had a part in the very beginning and all along the way.

The Water Tower, a publication of the company, in November, 1914 (Vol. 1, No. 3) contained a report of the founding of the company by George T. Horton, and a letter to Mr. Horton by Albert M. Blodgett '76 which evidently supplied some of the information for Mr. Horton's report. Among the five incorporators of the C.B. & I. in 1889 were Mr. Blodgett and Horace E. Horton, the father of George T. Horton. Mr. Blodgett's name appears again as one of three incorporators in 1881 of the Kansas City Bridge and Iron Company, which later became a part of the Chicago Bridge and Iron Company.

The two Hortons are mentioned without apology although neither is a graduate of Iowa State. Each was a friend of the College. Dean Marston has referred to them frequently as have several of our older alumni. They were engineers with ideas and imagination, successful businessmen, and able administrators who have helped many an I.S.C. graduate to get a start and,

more than that, to accept responsibility and to move forward.

S. H. Hedges '86, who is mentioned in the section on Dredging, was with the C.B.I. from 1893 to 1905 when he went to Seattle as president of the Puget Sound Bridge and Dredging Company. He was in charge of the St. Paul office for several years.

Carl H. Scheman '10, who went with the company on graduation, became president of the Horton Steel Works, Ltd., a Canadian affiliate of the C.B. & I. Now beyond retirement age, he served as consultant in the New York contracting office until the Spring of 1957, when he retired and is now living in Florida.

Six of our men began with the company in the Twenties: F. W. Schooley '22, A. W. Warren '22, C. L. Day '23, Wilbur Wilkins '26, John Marsh '28, and S. C. Hamilton '29. Schooley, who was Pacific Coast erection manager with headquarters at Los Angeles, was transferred to the Chicago office early in 1957. Warren, after a few years around the Chicago office and in the field, found this experience to qualify him for an attractive offer with another company, which later became Hoge-Warren-Zimmerman, and in which he is now President and continues in charge of the Chicago office. Day, after brilliant work in design, research, erection and sales, withdrew from the company and studied law. Hamilton was district sales manager at Houston, Texas, but early in 1957 was transferred to the main office in Chicago and was made general sales manager as well as a director of the company.

Wilkins has been continuously with the company and is now head of the engineering department at Salt Lake City, Utah. Marsh transferred to the Chicago, Rock Island and Pacific Railway in 1936 and is now bridge engineer for that organization.

Many other I.S.C. men have been and still are with the C.B. & I. They will doubtless get individual recognition by a future historian.

The records show a couple of interesting contacts with I.S.C. men and Hugh L. Cooper, not an alumnus. Mr. Cooper was a friend of Dean Marston and was well known as an outstanding engineer in the hydraulic power field. He will be remembered by many an Iowan as the engineer in charge of design and construction of the Keokuk dam and power house in and before the early Twenties.

Mr. Cooper had been with the C.B. & I. for several years

when he left in 1891 to go with the San Francisco Bridge Company where he was associated with J. C. B. Lockwood '85.

Economy Forms. An excellent illustration of the development of a new industry by an I.S.C. alumnus is the conception and growth of the Economy Forms Corporation. W. A. Jennings, who first registered in '18, graduated in '39. In the meantime he had developed an idea of building steel forms for concrete construction and putting them to work on a rental basis. The enterprise grew beyond all expectations. The small building in the northern part of Des Moines on U.S. 69 has been enlarged several times. The growth of the plant, offices and personnel, with I.S.C. men in many key positions, has but reflected the expansion of the building.

Mr. Jennings is still president and general manager. Other C.E. alumni whom he has brought in and developed for responsible positions are: D. S. Teter '23, field service manager; L. V. Kendall '24, treasurer and production manager, deceased; H. W. Crist '29, form equipment service manager; R. G. Finley '38, chief draftsman.

Twenty-one district sales offices have been opened from New England to the Pacific Coast. Among the managers of these offices are: Fort Wayne, Indiana, Floyd Skow '32; Dallas, Texas, Lawrence DeGraff '32 (withdrew from the company in 1956); Los Angeles, California, W. H. Witt '35; Cincinnati, Ohio, E. R. Kline '41. Many other alumni are on the way up. Each of them seems to believe in the enterprise. They often speak of the excellent spirit which Mr. Jennings has injected into the force and effective management which he is giving. The bimonthly paper Form Marks with business projects, athletic teams, and personal news from the various offices gives continuous indications that the project is on a substantial basis and in good hands. The number of employees in 1956 were: One hundred eighty-three in Des Moines office and plant; one hundred thirty-three in the field.

American Bridge Division, The U. S. Steel Corporation; Fabricated Steel Division, Bethlehem Steel Company. A large number of our alumni and faculty have either had a start or found a life's work with these two large fabricators of structural steel. Although we cannot claim a leading part in the development of either, the total contribution of I.S.C. graduates has been great, both as to the companies and the men. A similar statement might well be made for many other fields, including the Portland Cement Association, railroads, county engineers, etc.

MISCELLANEOUS

W. C. Armstrong '81 began with the bridge department of the C. & N.W. Railroad and remained with the railroad most of the time until his death in 1923. During 1895–98, he received valuable experience from another viewpoint with the Toledo Bridge Co., Toledo, Ohio, with M. J. Riggs '83. He returned to the C. & N.W. in 1909.

Among outstanding accomplishments were the construction of C. & N.W. viaduct over the Des Moines River, west of Boone, Iowa, and the C. & N.W. passenger stations in St. Paul and Chicago.

Other alumni who have been with the C. & N.W. Railroad include: E. C. Vandenburgh '08, chief engineer 1946 to 1952; B. R. Meyers '25, chief engineer 1952 to date.

M. J. Riggs '83 went through life with one employer, The Toledo Bridge Co., Toledo, Ohio. (After 1900 the Toledo Plant of the American Bridge Co.) Starting as draftsman, he served in various capacities, including engineer and manager. He was one of a few men of his time who had the vision to develop the small shop for the fabrication of steel bridges and buildings into effective production of various types of steel structures.

Clarence W. Hanson '23 was with the consulting engineering firm, Modjeski and Masters, from his graduation. He was a member of the firm and was taking high responsibility on many outstanding bridges and their complicated approaches until his death in 1958.

CONSTRUCTION

The construction industry is frequently referred to as the largest industry in the country with the possible exception of farming. No construction organization has the capitalization and number of employees as such industrial concerns as General Motors, General Electric and DuPont. Nevertheless, the large number of construction units, which operate as contractors or construction departments of governmental or private enterprises, make a tremendous total.

The size of the construction industry is generally overlooked in the educational and general discussions which keep the manufacturing industries in the lime-light. The civil engineers are quite a bit on the defensive much of the time. An excellent persentation of the C.E. viewpoint was made, in 1953, by Dr. Benjamin A. Whisler '30 in an address before the A.S.E.E. at Gainsville, Florida. He made a notable analysis of

the work of the civil engineer as compared with those in the manufacturing industries. He pointed out that the civil engineers, as a rule, went into some branch of the construction industry.

Construction Alumni. J. C. Meredith '78 was a student at Stevens Institute of Technology 1879–81. After more than twenty years of active practice, including railroad construction, river and harbor improvement, he went with the Florida East Coast Railway in 1904 as chief construction engineer on the Key West (Knights Key) Extension. A quotation from the TIMES UNION of Miami, Florida, reprinted in the I.S.C. ALUMNUS for June, 1909, and in the 1912 ENGINEERING DIRECTORY says he was "undertaking a work to which there were engineering problems which no man of his profession had ever been asked to solve, and his scientific deductions, when put into practice, have proven the greatness of the man in his profession."

"Upon the death of Mr. Meredith, the world has lost one of its greatest engineers, — and Miami has lost a true friend — Mr. Meredith's death is a distinct loss to the world."

Samuel H. Hedges '86, after miscellaneous experience in surveying, designing, and contracting in the Middle West, went to Seattle, Washington, in 1905 as president of the Puget Sound Bridge and Dredging Co. Up to his retirement in 1928, he had charge of much construction work in the Pacific Northwest and in Alaska. He also served as president of the Seattle Chamber of Commerce (1920) and as director of the American Society of Civil Engineers 1913–16. He died in Seattle.

Elbert Clyde Macy '96 retired in 1945 from active construction and administrative work which has taken him into many parts of the world. Within a decade, he showed the ability to assume responsibility and get results. He went with the Stone and Webster Engineering Corporation in 1905 and had direct charge of construction of the Niagara power station for the Buffalo General Electric Co. He stayed with Stone and Webster until 1924 and represented them in Japan in 1920.

His subsequent connections included: Dwight P. Robinson Co. 1924–27; Public Service Production Co., vice president, 1928; United Engineers and Construction, Inc., vice president, 1929–38 and again in 1941 to his retirement in 1945; Ulen & Co., vice president, 1938–40; Q. M. Department of the U. S. Army, Baltimore, Maryland, 1941.

The construction field has brought a most unusual experience to A. Q. Adamson '07. His first job was as Y.M.C.A. secre-

tary at Salt Lake City, Utah, and the second, Y.M.C.A. secretary at Foochow, China. In China he became so efficient in providing suitable housing for the Y.M.C.A. activities that he was called to various localities to design and erect Y.M.C.A. buildings. Subsequently his experience in construction took him to many countries. One of his later accomplishments was the construction of the efficient and beautiful Y.M.C.A. building at Jerusalem, Palestine, in the new part of the city. At Jerusalem he found it necessary to greatly expand the specifications in order that they could be understood by the local contractors. A framed photograph of that building adorns the walls of the C.E. offices at I.S.C.

Ross White '10 had early construction experience in Manila, Philippine Islands, California, Canada and Tennessee. He was general construction superintendent of the Tennessee Valley Authority 1935–37. Since 1938 he has been with Brown and Root, Houston, Texas, first as general manager, and since 1943 as vice president.

Francis K. Lytle '26 succeeded his father as president of the Lytle Construction Co. with headquarters in Sioux City, Iowa. The company has handled large contracts around and outside the United States. His son, Charles Francis, became executive vice president in 1956.

Ralph Green ex-'26 established the Green Construction in Des Moines. His work has also expanded and spread.

In recent years, the two companies have joined forces on large contracts in Alaska and other places.

Orville W. Crowley '13 had early construction experience with C. & N.W. Railroad, Iowa Highway Commission, including development and improvement of Iowa State Capitol grounds. He was general manager of Iowa Gravel Co. 1921–22, was executive secretary of Associated General Contractors 1923–42, Central Branch, May, 1942, to November, 1944, and project manager for Lytle and Green in charge of construction and maintenance of Alaska section of the Alcan Highway. Since November, 1944, he has been executive secretary of the Associated General Contractors of Iowa.

Mr. Crowley, through the years, has kept closely in touch with his Alma Mater. He has responded to many requests to tell the undergraduates about the construction field. By formal talks and informal conferences, he has brought inspiration and guidance and has thereby been a deciding factor in the placing of many men in the beginning of a successful construction career.

THE MARSTON MEDAL

The Anson Marston Medal, which is given annually to an outstanding engineering graduate of Iowa State College, was established in 1938. The award was inspired by Anson Marston, who was Dean Emeritus at that time. The winner of the award is selected by a representative from each of the four engineering societies: The American Society of Civil Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Institute of Chemical Engineers. On the board, in addition, are four engineering alumni, one chosen each year for a four year term by the class which is celebrating its twenty-fifth year reunion. The Dean of Engineering of the College is ex-officio chairman.

The award is made only to an engineering alumnus of thirty years standing. Since 1939 no candidate has been eligible until his name has been before the board of award for at least one year.

A list of the Civil Engineering award winners and the year of the award follows:

Thomas Harris MacDonald	C.E. '04	1939
Henry John Brunnier	C.E. '04	1941
LeRoy Lemayne Hidinger	C.E. '06	1942
Laurence Timmerman Gaylord	C.E. '04	1944
Thomas Radford Agg	C.E. '05	1947
Roy Winchester Crum	C.E. '07	1948
Fred R. White	C.E. '07	1952
James O. Jackson	C.E. '17	1956

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    c. Hammond 1940
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    e. Humanistic-Social 1946; 1956
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18. Engineering Education.
19. Civil Engineering.
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25. Gladys Hultz Meads, "The Squaw and the Skunk," 1955.
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27. Polk City Directories of the City of Seattle, Washington, 1889–1900.

APPENDIX

CARRYING OUT THE TWENTY-YEAR PLAN AND A FORECAST FOR THE NEXT TWENTY YEARS

By Lowell O. Stewart

THE TWENTY-YEAR PLAN, 1935-55

In 1935 Iowa State College, under President Hughes' direction, prepared a comprehensive twenty-year development program. In that report the objectives of Civil Engineering Training were stated by Almon H. Fuller, Head of the Department, to be ..."to send out into the world young men who are trained in the principles underlying the practice of all of the phases of civil engineering; who have definite experience in the applications of a few of those principles; who have the resourcefulness to extend the application of principles to fields beyond their experience; who have the personal qualities necessary to maintain human contacts and to develop into successful engineers and useful citizens; and the desire and adaptability to conform to the Objectives of Engineering Education as outlined in the preamble to the divisional program."

It was stated further under objectives:

"Scholastic improvement and a broadening of viewpoint lie more in the spirit of the teaching than in further change in curriculum content. One of the objectives to be striven for immediately is to secure greater effectiveness in teaching, especially for the students who show the capacity and the desire for real accomplishments.

"An effort will be made to stimulate personal qualities along the following lines:

1. "To provide adequate guidance, example and training to build students into better men and women, into useful members of society; to give them more skill to live happily and effectively in their environment. To develop the best in character, personality and ability in each student.
2. "To develop as much leadership ability as possible in each student, both leadership in his own professional field, and in public affairs at large:

   a. By attempting to teach him the technic of leadership.

b. By endeavoring to aid in the development of the necessary personal traits and qualities.

c. By providing experience in his regular courses in the independent solution and presentation of problems of the general type he will meet in the future. In the solution of these problems the principles and standards of scientific thinking will be applied. This type of training will be a prominent feature in the senior year.

3. "To expose him to such situations as will tend to give him some appreciation and understanding of the true, the beautiful, and the good."

The foregoing from the 1935 TWENTY-YEAR PLAN has been quoted in detail because it characterizes accurately the spirit and goal of the educational program of the Civil Engineering Department. Its fulfillment cannot be measured by a comparison of statistics. It must rather be judged in terms of the accomplishments of our alumni, and by their attitudes toward and respect for the members of the Civil Engineering staff. In both of these aspects the record shows gratifying growth through the years.

AFTER THE TWENTY-YEAR PLAN

The Twenty-year Plan was drawn up during the period known as the Depression. Since that time many events have occurred that had an important effect on engineering education. Among these are World War II, the Korean "Incident," steadily increasing birth rate and corresponding increase in the numbers of men and women who enter college, an increasing emphasis on scientific and technological education.

Naturally, the 1935 Report did not anticipate those developments. It predicted a need for about forty civil engineering graduates from Iowa State College per year. The number rose to a maximum of one hundred and twenty-five at the peak of the veterans (G.I.) influx in 1949, (125 B.S., 13 M.S., 1 Ph.D.). It dropped to the middle Fifties, and then began to rise in 1956 when there were ninety-six graduates (62 B.S., 29 M.S., 2 Ph.D.). Of course, an important aspect of this growth is that employers took everyone in sight and clamored for more.

The Report estimated a need for about nine full-time staff members. In 1956 the total was twenty-three. Of these the equivalent of fourteen was engaged in teaching and nine on research and other activities. This growth in graduate teaching and research will be discussed in more detail later.

The enrollment in the College, the Engineering Division, and in Civil Engineering has more than doubled since 1935. The 1950 census figures compared with the 1930 figures indicate an increase in student enrollment of about twenty-five percent in Law, Medicine, and Architecture, and more than one hundred percent in "Technical Engineers." A breakdown for engineering enrollment shows an increase of about fifty percent in civil engineering and more than one hundred percent in chemical, electrical, and mechanical engineering.

Enrollment at Iowa State College shows:

	1935	1955	1956
Iowa State College	3,000	8,000	9,670
Engineering	1,200	3,000	3,340
Civil Engineering	150	300	370

Graduates. As mentioned earlier, the number of civil engineering graduates has turned upward again, and reached sixty-two with B.S. degrees in 1956. In numbers and in percentages civil engineering enrollments everywhere have not kept pace with those in electrical and mechanical engineering. The reasons for this lie in publicity, glamor and popular appeal, and not in the opportunities for employment and advancement in professional development or salary.

This department has been having as many students and graduates, (both B.S. and advanced) as its faculty and physical facilities could handle effectively. The current rapid upward trend of engineering enrollments portends difficult administrative problems ahead for deans and department heads. An increasing percentage of total staff time is going to graduate work and research, although the total student-teaching load is increasing most rapidly at the under-graduate level. Moreover, opportunities and salaries in industry are numerous and attractive, and it is hard to find candidates for teaching positions. And, when the younger teacher and graduate student who does go on for the Ph.D. degree has earned that degree, he often is no longer interested in teaching exclusively at the undergraduate level.

The number of M.S. and Ph.D. graduates at Iowa State College has been rising since the 1940's. One reason for the increase in M.S. graduates is the program of the Corps of Engineers. Beginning in 1947, and again in 1948, 1949, 1955, 1956, the Chief of Engineers has sent twelve to fifteen engineer officers here for one calendar year of graduate work, leading to the M.S. degree. At the same time, the number of "non-military"

graduate students has increased as our research program has expanded. The latter will be discussed in more detail later. However, very few men can afford to spend the time or money to attend graduate school without a substantial subsidy. In fact, industrial companies are now giving a good deal of attention to the need and desirability of offering financial aid to students who wish to attend graduate school and do research.

For a number of years after the 1930's the department had no Ph.D. candidates. During recent years there have been one to four candidates each year. It is hard to estimate our capacity to handle Ph.D. candidates. Perhaps three or four per year is a reasonable number. It depends, in part, on distribution of their major and minor fields of concentration. For example, recently there has been an increasing interest in and demand for graduate courses in the soil engineering area under Doctor Davidson. Structures has always been a major field for the Ph.D. Sanitary under Doctor Baumann is growing. And highways under Professor Csanyi should have many Ph.D. candidates in the future. In all of these areas the increase in the number of graduate students parallels the increase in support for civil engineering projects of the Engineering Experiment Station.

Research. Nearly forty research projects were anticipated and named in the Twenty-Year Program. Many of these have been completed. Others are in process. In addition, new projects have been developed, particularly in the areas of soil stabilization and the treatment of soils with asphalt. Most of this research centers around efforts to find ways of utilizing available and low-cost materials for roads.

This expansion in the research program is the result of several causes, among which are: (1) widespread recognition of the need for intensified and expanded research programs by industries and colleges, coupled with the increased availability of funds for that purpose; (2) the increasing desire of members of the faculty to engage in basic and applied research, a desire abetted in part by the need of an advanced degree by those who wish to advance academically; (3) the establishment of the Iowa Highway Research Board in 1950.

Our research activity has increased markedly since 1950 when the Iowa Highway Research Board was established. In 1956, for example, professors of this department were in charge of $172,000.00 worth of projects sponsored by that board. And, in the sanitary field, in 1953 the U. S. Public Health Service

sponsored a project on the cooking of garbage for $39,000.00, and another in preaeration for about $16,000.00 in 1956. These figures may be compared with a total research budget for civil engineering of $21,000.00 per year prior to 1950. In structural engineering the studies have dealt with the shear strength of prestressed concrete, the fatigue strength of a section with welded cover plates, and the design of wing walls for bridge abutments with constant and variable thickness.

Staff. The staff has grown in numbers since 1935. As mentioned before, this increase in size has come because of the expansion of our graduate and research programs and the growth of our student body. For example, we have twenty-three men on the civil engineering staff now. Professor Fuller has been part-time on research, engaged in the preparation of this History of Civil Engineering; Professor Caughey has reached the age of seventy and is on half-time teaching; Professor Stewart is engaged largely with administration. Of the other twenty men, one is spending part-time counseling freshmen and sophomores, one is working part-time on Engineering Extension, eleven are part-time on research with the Engineering Experiment Station, eight are engaged in teaching full-time. This gives us the equivalent of about fourteen full-time teachers engaged in undergraduate teaching. Roughly, one-fifth of their time is given to graduate teaching.

The major interests of the staff are divided as follows: in highways, 4; in sanitary, 3; in soils, 6; in structures, 6; in construction, surveying, and miscellaneous, 4.

In the area of advanced degrees, six have the Ph.D., one the Sc.D., fifteen have the M.S. Seven are pursuing graduate work and research leading to the Ph.D.

Engineering Extension. A growing activity of this department is in several related areas of Engineering Extension. The department has worked with Engineering Extension, the County Engineers' Association, and the Iowa Highway Commission in sponsoring the annual meeting of the county engineers. Professor Stewart was given a service award by this association in 1955 in recognition of the effective work that he and the department had done.

Similarly, Professor Lubsen and Professor Stewart, and the late Professor Dodds have been the leaders in planning the Annual Surveyor's Conference, also sponsored by Engineering Extension. At the winter 1957 meeting of this conference Pro-

fessor Lubsen and others took the lead in organizing an Iowa Land Surveyors' Association. Professor Stewart, Harold Steinbrecher (I.S.C. C.E. '24), and Carl Smedal, an attorney of Ames, were made honorary members.

In the late 1950's the department and Engineering Extension held some week-long short courses for men interested in learning the latest developments in soil engineering and bituminous materials and pavements. Professors Csanyi, Davidson and Spangler were the instructors. The motivating demand for these courses came from the county engineers. However, engineers from the Iowa Highway Commission, cities, consulting firms, and others who had an interest in this work were invited to enroll in the course.

Recently there has been a revival of interest in short courses for sewage and water works operators. Many years ago Engineering Extension carried on a continuing program with a man (L. J. Murphy, I.S.C. B.S. C.E. '21, M.S. C.E. '24, P.E. '26) in charge of that work. Later, Professor W. E. Galligan, then on this staff, was in charge of an Engineering Extension correspondence course that was designed to prepare sewage plant operators for accreditation. Now that work is receiving renewed attention; Engineering Extension is placing Professor Morgan of this staff on its staff part-time. He will conduct classes for operators at various places in the state and on the campus. Interest in this has been motivated by the continuing desire to improve the operation of sewage plants in the state. Doctor Baumann and Professor Cleasby, also, have worked closely with the operators and the State Department of Health.

The structural staff have taken part in several seminars on design. Included in these are: Design of Cylindrical Concrete Shell Roofs, sponsored by the Portland Cement Association, at Des Moines; and, a Conference on Plastic Design in Structural Steel at Ames.

The City Engineers' Association of Iowa has had the help of Professor Stewart for many years in the planning of their annual program. These are held annually at the College under the joint sponsorship of the Civil Engineering Department and Engineering Extension. As is true with the county engineers, these annual conferences have been an important factor in advancing the profession, improving public relations, and in developing a stronger esprit de corps.

Consultation. Several members of the staff have carried on consultation services which have served to increase their usefulness to the community and to the college. Doctor Baumann has helped several communities with their sanitary problems. Professor Caughey, over the years, has given advice on the condition of many structures. Doctor Hulsbos is taking up that work as Professor Caughey retires. Doctor Davidson and Professor Spangler have given an increasing amount of attention to soil and foundation problems, with Professor Spangler called on frequently to investigate culvert loadings, and to serve as consultant for the Federal Government. Professor Csanyi is a consultant on traffic and pavements for the City of Ames, Iowa State College Physical Plant, and others. Professor Lubsen is well known in the state of Iowa for his work on property line surveys. The late Professors Dodds and Schlick were well known for their consulting work, Dodds in land surveying, Schlick in drainage.

One of the department's important cooperative activities has been Professor Hosmer's work with the Associated General Contractors of Iowa through Orville W. Crowley (I.S.C. B.S. C.E. '13), its executive secretary, and the association's educational committee. In connection with the teaching of engineering construction, C.E. 485, they have each quarter furnished a panel of contractors, who have presented some of the viewpoints of the contractors at regular meetings of the class. This has helped to stimulate interest in construction and contracting as a career, and has increased the effectiveness of the course material.

Professional and Technical Growth. Two of the tangible measures of professional and technical growth are membership in a technical society and engineering registration. The department has a very good record in each of these areas. While members of the Student Chapter, American Society of Civil Engineers, the students learn some of the responsibilities of a civil engineer as an individual and as a member of the group. Their success in this area is attested by the fact that the student chapter has received the National President's commendation many times, and by the winning of several divisional and college-wide awards for the best open-house during Veishea.

A high percentage (probably more than eighty) of the civil engineering seniors take the engineer-in-training (fundamentals) portion of the engineering registration examination, which is offered during their last quarter in college.

Similarly, a high percentage apply for membership as junior members of the American Society of Civil Engineers before they leave upon graduation.

In both cases this favorable record is helped by staff action and by a letter which Professor Stewart writes to each senior during his last quarter. Also, active interest and participation in society affairs by members of the staff have a good effect upon student response. For example, Professor Stewart was secretary of the Iowa Section, A.S.C.E., for sixteen years, and has been succeeded by Professor Hulsbos. Professor Stewart is also a member of the State Board of Engineering Examiners.

Curriculum. Reference is made elsewhere to the five reports of the A.S.E.E. (and S.P.E.E.). All of these reports have recognized and emphasized the importance of the teacher in the educational process. However, the aspect that has received a great deal of attention, perhaps the most, is the curriculum which seems to be looked upon as the magic vehicle that holds the key to a proper engineering education.

From the beginning of these reports, the engineer and his education were charged with showing a serious deficiency in the area of human relations. Moreover, it has been assumed continuously that this deficiency could be, and would be, corrected if the engineering student would study a core of "cultural" subjects. These have been designated the Humanistic-Social courses or "stem" and their magic percentage is twenty percent of the total engineering curriculum.

In 1955 an A.S.E.E. Committee went further than the earlier reports and included details about the areas and percentages of those areas that should be included in an accredited curriculum. The Engineer's Council for Professional Development (E.C. P.D.), which is the accrediting agency for engineering curricula, followed this by incorporating most of the A.S.E.E. recommendations into its accrediting criteria. These reports and action have generated a good deal of controversy. The American Society of Civil Engineers, in particular, believes that the criteria are too heavily weighted for the needs of those engineers who enter scientific and industrial fields. However, there is general agreement that there must be increased emphasis on the scientific content of the curriculum without any lessening of attention to the humanistic-social content.

Among the points emphasized by the A.S.E.E. 1955 Report was the need to eliminate or markedly reduce the manipulative course content of the curriculum. Although there is disagree-

ment among engineering educators as to the true meaning and purpose of the so-called "manipulative" courses, it is agreed, generally, that those courses which teach *only* how to do something with the hands have no place in an engineering curriculum. The difficulty in applying this criterion is that the cases are not as simple as that.

Reduction in the purely manipulative course content of the curriculum has been going on for years. Mechanical shops, such as forge and foundry, have been eliminated or greatly altered; engineering drawing and surveying content have been reduced. In our civil engineering curriculum a number of adjustments over recent years have moved material from other courses, such as highways, into surveying, for example, road plans and earthwork calculations. So our surveying courses represent more than the teaching of the principles and techniques of surveying. However, it has seemed necessary that we examine the surveying content of our curriculum and note what is going on in other civil engineering curricula. There we observe that there have been drastic reductions in the surveying content at many schools. Some have eliminated surveying on the campus and have placed it in a summer camp.

As a result of this study, our surveying content has been reduced from twenty-one to eighteen credits, nine on the campus, nine in our six weeks summer camp. Perhaps the future will see a further reduction of surveying courses on the campus, and perhaps an increase in summer camp.

This reduction of three credits in surveying makes room for the addition of differential equations, which the E.C.P.D. accrediting committee in 1955, when we were accredited for a five year period, suggested that we do. These changes appear in the 1957–58 Iowa State College catalog.

Another change in our curriculum which became necessary though regrettable was replacing engineering reports, C.E. 484, with English 414, writing of scientific papers. Engineering reports has made many valuable contributions to the education of our students. Although the course content was valuable, one of the principal values of the course has come from the students' contact with men who have taught the course. This includes many of the distinguished teachers of this department: Agg, Dodds, Foster, Kerekes, Schlick, Winfrey, and others. Unfortunately, but understandably, the newer generation of teachers does not wish to give the time that is necessary for the effective teaching of engineering reports, and it seems unwise to ask any-

one to teach it who is not interested. For this reason we are turning to English 414, which is a good reports course.

Clearly, this demand from A.S.E.E. and E.C.P.D. for more emphasis on the basic scientific content of the curriculum, with no lessening of attention to the humanistic-social content, calls for one of two solutions. One is an increase in the number of credits required for the B.S. degree; the other is a readjustment and rearrangement of the present courses to make room for new ones. Current thinking of A.S.E.E. does not include any lengthening of the curriculum for the B.S. degree beyond the traditional four years. So, we must make adjustments in our present curricula. We will continue our study of our curriculum, and get ready for the recommendations of the American Society of Civil Engineers which is studying the needs of civil engineering education.

Another factor in this problem is the place of advanced military. Heretofore, students taking advanced military (R.O.T.C., etc.) have been permitted to substitute military courses for certain marked courses of the curriculum. In most instances these starred courses are in the humanistic-social area. This means a reduction of that content for all advanced military students. The E.C.P.D. recommends that this practice of permitting the substitution of military courses for other required courses in the curriculum be discontinued. Naturally, the military officials are opposed to this because it would require extra time for the graduation of students who are taking advanced military. A few engineering colleges do not permit this substitution now. Others, doubtless, will follow. The whole question is now under discussion with the E.C.P.D. taking a rather firm stand in its recommendation that the practice be stopped.

THE NEXT TWENTY YEARS, TO 1975

Enrollment. A reasonable estimate by the Registrar and others at Iowa State College places our probable college enrollment at 16,000 in 1970. In view of the fact that our engineering enrollment was 3,342 for the Fall Quarter of 1956, in a total of 9,673 for the college, it is not improbable that there could be between five and six thousand engineering students here in 1970. The percentage enrolled in civil engineering is now about eleven percent of the engineering enrollment. Using a future figure of ten percent for civil engineering, we could expect that five to six hundred of this 1970 predicted enrollment might be in civil engineering.

There are several factors that may have an important effect on this predicted enrollment for engineering. Among these are higher scholastic standards, enrollment restrictions, increased emphasis on science, a lengthened engineering curriculum, a shortage of engineering teachers, and others.

Under present regulations any graduate of an Iowa high school may enroll at Iowa State College. Recent stories about the shortage of engineers have brought young men into the engineering colleges who do not have the aptitude or ability to do the course work of an engineering curriculum. If our Engineering Division were to set up the requirement that a high school graduate who seeks to enroll in engineering must rank in the upper one-third of his high school class it is probable that there would be a substantial reduction in the size of the entering class. This move combined with higher scholastic standards at the College would tend to decrease the number of engineering students to a figure below the estimated five to six thousand in 1970.

Increased emphasis on science in the engineering curriculum, as recommended in recent A.S.E.E. reports, could have an adverse effect on the size of engineering enrollments. Many students fear and have trouble with the scientific and mathematical courses and tend to avoid them both in high school and in college. This attitude may change if high school programs are revised to include the effective presentation of these courses to all high school students.

As long as the current strong demand exists for engineering graduates at attractive salaries, it will be hard to obtain the engineering teachers that will be needed to do a good job of teaching. Probably, money for salaries will not be provided by the state legislature, and industry will hire the engineers at attractive salaries. Doubtless, this resulting shortage of engineering teachers will call for changes in our teaching methods: there will be larger sections; there will be more lecturing; the number and use of laboratory work will be reduced, and the length of laboratories will be changed from three to two hours.

Lengthening the Curriculum. There has been discussion for many years about increasing the length of the engineering curriculum, say to five years. A few engineering colleges, for example Cornell and Minnesota, have the five-year requirement for the B.S. degree. In the main, the thinking of men in industry and leaders in college education has been that four years are enough to give the student the necessary fundamentals to

prepare him for the start of his engineering career. Also, there was the belief that the young man could not afford the added financial burden of another year in college. Now, as the areas of knowledge continue to expand at a rapid rate, it seems probable that we will move soon to the requirement of five years for the B.S. degree in engineering.

Professional Growth. There are other trends that will influence both engineering education and the development of the profession. Among these are: increased attention to the scientific courses and decreasing attention to the "practical" or "hand work" type of courses, as has been mentioned; closer relationship between the department of civil engineering and the employers of civil engineering graduates, including more scholarships, more effective recruitment programs, more and better organized training programs for the recent graduates, more effective use of the young engineer's ability; the growing interest in educational procedures, including advice on the shaping of curricula, by technical societies, such as A.S.E.E., A.S.C.E., and E.C.P.D. This active interest is beginning to have a marked influence upon engineering education, similar to that exercised by the American Medical Association over medical education; the development of a "professional" attitude, as contrasted with that represented by the unionization movement; increased interest in registration as a professional engineer; increased interest in and emphasis on advanced degrees, both in industry and as a prerequisite for advancement in college teaching.

Technicians. As has been pointed out in many studies, there is a need for men with technical educations of a lower scientific order than that of engineer. These men, named "technicians," would do the detailed work such as computing, drafting, testing, instrument work, and others, and leave the engineers to do those things that are truly of an advanced nature. Separate schools must be provided for their education and suitable curricula must be developed, as has been done in a few schools.

Professionalism vs. Unionization. Engineering has rated itself as a profession, similar to medicine and law, for a long time. Yet certain features that seem to be inherent in the work and employment of engineers have made it difficult to establish, clearly this idea of professionalism. Registration as a professional engineer by all engineers is urged as one of the solutions for this dilemma.

A parallel movement, which some of its advocates claim is not incompatible with professionalism, is that of the unionization of engineers. This has its strongest appeal and strength in some of the mass production industries, such as aircraft. Here we find large numbers of engineers engaged in similar work, some of it routine.

This issue of the place of a union in the proper and effective growth of an engineer cannot be ignored or left to chance. The process of educating and informing the engineer must begin in college, and be continued through his technical societies, which he must support, after graduation.

Advanced Degrees. With the increasing undergraduate enrollment there is a similar growth in graduate work and research. New knowledge and the need for its understanding and use, as well as a changing attitude on the part of employers toward the need for making use of this new knowledge, have made it financially worthwhile for B.S. graduates to go on with advanced study. Of course, advanced degrees have always been a "must" for those who do research. Recently employers of engineers have begun to pay more than "token" differentials in salary, above the B.S. graduates, to those who have advanced degrees.

Graduate study and research through completion of the Ph.D. degree are assuming increasing importance for those who wish to make a career in engineering teaching. The rating of a department or a school is measured, to a significant extent, by various agencies, according to the number of men with advanced degrees (Ph.D.) on its staff. Of course, this method of rating is based on the assumption that teachers with advanced degrees will do a better job than those who do not have the advanced degree. Unfortunately, the end result of this chain of events is that an engineering teacher who earns a Ph.D. loses his interest in teaching undergraduate students, particularly freshmen and sophomores. Consequently an increasing amount of the teaching of undergraduate students will be done by "beginning" instructors with little or no teaching or practical experience. This is different from the situation of an earlier day when young students were inspired by the older and experienced teachers.

Space. It is well known that there is a severe shortage of space in all departments of the engineering division. Civil engineering has adequate laboratory space in highway, sanitary, soil and structural engineering for a five to ten year period. It needs space now for a photogrammetry laboratory, and a fire-

proof building for the safe storage of valuable surveying instruments. It needs, immediately, more office space. It needs, soon, additional classroom and design laboratory space.

The classrooms and laboratories that are built for future use should include facilities for projecting slides and motion pictures, and television. It should be possible to darken windows quickly and conveniently.